United Nations Environment Programme

Distr.
LIMITED

UNEP/OzL.Pro/ExCom/8/15
23 September 1992

ORIGINAL: ENGLISH

Executive Committee of the
Interim Multilateral Fund for the
Implementation of the Montreal Protocol

Eighth Meeting
Montreal, 19-21 October 1992

COUNTRY PROGRAMME: GHANA

This document consists of:

a) Evaluation Sheet (prepared by the Fund Secretariat)

b) Country Programme Cover Sheet

c) The Country Programme

GHANA COUNTRY PROGRAMME EVALUATION SHEET

The Ghana Country Programme is submitted to the Eighth Meeting of the Executive Committee as document UNEP/OzL.Pro/ExCom/8/15. The document was prepared in accordance with the "Procedures for Presentation of Country Programmes and Project Proposals to the Executive Committee" (UNEP/OzL.Pro/ExCom/5/5/Rev.2).

It consists of:

Letter of Transmittal from the Government of Ghana;
Country Programme Cover Sheet;
Executive Summary;
Introduction;
ODS consumption and trends in Ghana;
Industry structure;
ODS demand forecast;
Institutional framework;
Implementing the Phase-out (Response to the Montreal Protocol);
Recommended Phase-out strategy;
Action Plan.

The Country Programme also contains detailed project proposals (Annex A).

Ghana imports all its ODS requirements. In 1991, total consumption in the country was 102 tonnes of ODP. These were distributed as follows (tonnes ODP):

- servicing of refrigeration equipment: 73
- flexible foam industry: 24
- solvents: 2
- fire fighting: 3

In developing a strategy for phasing-out ODS in Ghana, two scenarios were considered.

1. Allowable Phase-out: the 10-year grace period is fully utilized and phase-out is postponed until the latest possible date, while keeping the country within the limits of the Montreal Protocol.

2. Accelerated Phase-out: Phase-out is undertaken at a pace set by the availability of technology. Transition to ODS substitutes is accomplished over the period 1992-1998 except for servicing of refrigeration equipment.

The total incremental cost of phasing-out the ODS in Ghana was estimated at US $2.5 million to US $8.7 million in the accelerated and allowable phase-out scenarios respectively. The difference in the cost is due to the high cost of pre-mature scrapping of CFC-based refrigerators.

The adoption of the accelerated phase-out strategy gives the following phase-out schedule:

a) Freeze in consumption at 1991 levels by 1993;
b) 50% reduction by 1995;
c) 75% reduction by 1998;
d) 85% reduction by 2007;
e) 100% reduction by 2010.

The residual 25% consumption after 1998 is mainly due to servicing of domestic refrigerators and air-conditioners.

Two peculiar problems were identified in the Country Programme. These are:

a) The high dependence on import of second-hand refrigerators due to the inability of consumers to buy new refrigerators. It is assumed that this factor could affect the change-over to CFC-free refrigerators which would not be generally affordable until about the year 2006.

b) The need to keep in service as many CFC-refrigerators as possible necessitating the establishment of a "CFC-12 Security Stock" or "CFC-12 Bank". The CFC-12 Security Stock is estimated at US $480,000 (at 1993 prices).

The Action Plan proposed for phasing out the ODS is based on the accelerated phase-out scenario. It is made up of establishment of appropriate institutional framework, regulatory measures, monitoring, training, information dissemination and creation of awareness and technology transfer.

The Environmental Protection Council will be the lead agency for the implementation of the Action Plan assisted by a dedicated Ozone Office within the Council, an inter-departmental National Committee on Ozone Depletion Substances and a specialized National Committee for Improved Refrigeration Practices.

Three project proposals for which funding is requested from the Executive Committee have been developed in detail and attached as Annex A to the Country Programme. These are:

- Institutional Strengthening for the phase-out of ozone-depleting substances — US $160,000

- Improved servicing and maintenance within the refrigeration sector — US $427,000

- Elimination of ozone-depleting substances - Technical assistance for the elimination of CFC-11 in the flexible foam manufacturing sector — US $ 85,000

All the projects will be implemented through UNDP.

Recommendation

The following recommendations are made for the consideration of the Executive Committee:

1. Approval of the Country Programme.

2. Approval of funding level of US $573,000 for the implementation of the projects developed within the Country Programme. (This takes into account US $99,000 provided for Ghana within the UNDP Work Programme for 1991) (UNEP/OzL.Pro/ExCom/5/8).

3. The establishment of the CFC-12 Bank (CFC-12 Security Stock) (Project R-1.4) costing US $480,000 be considered a policy issue requiring further consideration by the Executive Committee, and the decision on it should be deferred until a policy decision has been taken on the issue.

COUNTRY PROGRAMME COVER SHEET

COUNTRY: **GHANA**

LEAD NATIONAL AGENCY; **ENVIRONMENTAL PROTECTION COUNCIL**

LEAD IMPLEMENTING AGENCY: **UNDP**

DATE RECEIVED: **21 September 1992**

PERIOD COVERED BY COUNTRY PROGRAMME: **1992 (3rd quarter) - 1995**

1. Phase-Out Schedule

Substances	Current Consumption (tonnes x ODP) 1991	Planned total consumption until phase-out (tonnes x ODP)	Planned year complete phase-out
CFC-11	36	300	2010[2)]
CFC-12	60	800	2010
CFC-113	0	?[1)]	2000
CFC-115	< 1	< 20	2010
Halon 1211	< 3	< 70	2007
CTC	2	20	2000
MCF	0	?[1)]	2005
Total	102	4,500	

[1)] It is not known to what extent this substance will be used for military purposes.
[2)] Consumption of CFC-11 for flexible foam manufacturing will be phased-out before 1995.

2. Government Action Plan

Year(s)	Description of Action	Sector	Intended Effect	Estimated Cost US $
1991	Establishment of monitoring system for ODS import and use	All	Ensure compliance with Protocol	-
1992-95	Strengthening institutional framework	All	Provide monitoring and co-ordinating	160.000
1992	Establishment of National Committee on ODS	-		
1992	Establishment of Ozone Office	-		
1992-95	Public Awareness Campaign	All	Create Awareness	
1992-95	Enactment of regulations and provision of incentives and penalties	All	To ensure compliance with Action Plan	-
1992-95	Certification of refrigeration technicians	Refrig-eration	To ensure improved servicing	
1993	Establishment of Refrigeration Demonstration Centre	Refrig-eration	Trained technicians	
1993	Establishment of National Committee on Improved Refrigeration Practices (NCIRP)	Refrig-eration	To supervise activities in refrigeration sector	
1993-95	Improvement in servicing and maintenance of refrigeration equipment	Refrig-eration	To reduce consumption of CFC during servicing	427,000
1993-95	Training of refrigeration technicians	Refrig-eration	Ensure improved servicing and maintenance	

Year(s)	Description of Action	Sector	Intended Effect	Estimated Cost US $
1993-94	Improvement in supply of nitrogen for servicing of refrigeration equipment	Refrig-eration	To guarantee availability of nitrogen to reduce consumption of CFC	
1994-95	Introduction to retrofitting of industrial refrigeration systems	Refrig-eration	To ensure adoption of proper retrofitting techniques	
1993-94	Establishment of CFC-12 refrigerant stock	Refrig-eration	To ensure availability of CFC-12 refrigerant to avoid premature retirement of domestic refrigerators	
1993-94	Adoption of measures for the elimination of CFC-11	Foam	To phase-out use of CFC-11	

3. Project Summary

Year(s)	Type of Project	Project Description	Project Cost	Incremental Cost	Participating Implementing Agency	Tonnes x ODP Phased-out/ Year
1992-95	Institutional Strengthening	Establishment of monitoring and co-ordinating mechanism for implementing programme to phase-out ODS	160,000	160,000	UNDP	N.A.
1992-95	Training; Demonstration ; Technology Transfer	Improved Servicing and maintenance within the Refrigeration Sector	427,000	427,000	UNDP	50
1993-94	Technology Transfer; Training	Elimination of the use of ODS in the Foam Sector	85,000	85,000	UNDP	24

4. Costs

	US $
Cost of activities and projects in Country Programme	1,152,000
Estimated cost of complete phase-out	2,500,000
Estimated cost effectiveness (US $ per tonne ODP)	0.3

Ghana

Country Programme

for the Phase-Out of

Ozone Depleting Substances

September 1992

Submitted

to the

Eighth Meeting of the Executive Committee
of the Interim Multilateral Fund under the Montreal Protocol

ACKNOWLEDGEMENT

This Country Programme was prepared by the Government of Ghana with assistance from the Government of Denmark through UNEP-IE/PAC who also assisted in organizing its preparation and data gathering. The Ghanaian lead agency on issues related to the Montreal Protocol is the Environmental Protection Council (EPC) under the Ministry of Local Government. The EPC is assisted in matters of ozone layer protection by the National Committee on Ozone Depleting Substances. At the request of the Government of Ghana the Fund Secretariat participated in the national seminar to discuss the draft document and offered some guidance and assistance in the revision of the final draft.

The Government of Ghana expresses its gratitude to the Government of Denmark, UNEP, the Fund Secretariat and all other agencies and individuals who assisted in the preparation of the Country Programme and hopes for continued co-operation in the implementation of the plan of action developed within it.

EXECUTIVE SUMMARY

Background

1. The Montreal Protocol is an international agreement to reduce the consumption of chlorofluorocarbons (CFCs) and halons. It was signed in Montreal, Canada in September, 1987 and has since been ratified by over 70 countries worldwide. In June 1990, the Protocol was amended to include other ozone depleting substances (ODSs), namely methyl chloroform (MCF - otherwise known as 1,1,1-trichloroethane) and carbon tetrachloride (CTC). The amended Protocol requires a complete phase-out of CFCs and halons by the year 2000 but developing countries with a calculated per capita consumption below 0.3 kg are allowed a further 10 years to phase-out their use of ODSs. It should be noted, however, that ODSs used in export products have to be phased-out by 2000 as the 10 year delay provision only applies to ODSs used to meet basic domestic needs.

2. Under the Montreal Protocol, the participating countries have established the Interim Multilateral Fund (Multilateral Fund) to help finance the incremental costs of meeting the requirements of the Protocol in developing countries and promote an accelerated phase-out of ODSs.

3. Ghana became a party to the Vienna Convention on 22 October, 1988 and ratified the Montreal Protocol on 24 July, 1989. Ghana also ratified the Amendment to the Protocol on 22 July 1992. The per capita consumption of ODSs is estimated at 0.007 kg in 1991. Thus, Ghana qualifies under paragraph 1 of Article 5 of the Protocol for a ten year delay in the phase-out of ODSs, and the country is eligible for assistance from the Multilateral Fund.

4. At the request of the Government of Ghana, the Government of Denmark through UNEP-IE/PAC provided assistance to the preparation for this Country Programme, a requisite activity for assistance from the Multilateral Fund. In accordance with the Executive Committee's guidelines for Country Programme preparation, the report contains an examination of the pattern of ODS consumption in Ghana, analyses of alternative ODS phase-out scenarios, description of the recommended phase-out strategy including an estimate of the incremental costs of a complete phase-out, and an action plan for Government activities and proposed projects for which the Ghanaian Government seeks assistance from the Multilateral Fund.

Use of ODSs in Ghana

5. There is no production of ODSs in Ghana. These substances are all imported by a limited number of local distributors and directly by the ODS-using companies. The total import of CFCs has been estimated at approximately 97 metric tons (MT) in 1991 of which CFC-11 and CFC-12 account for almost 99%. Approximately 1 metric ton of CFC-115 is used in the composite refrigerant CFC-502 consisting of 49% HCFC-22 and 51% CFC-115. Consumption

of other ODSs including carbon tetrachloride and Halons is estimated at 2-3 metric tons. In terms of ODP weighted ODS consumption, the total has been estimated at 100 metric tons. Refer to Figure 2.

6. The dominant part (73%) of consumption of controlled ODS is used for servicing of existing refrigeration equipment and to a minor extent also for installation of new equipment. No manufacturing of domestic refrigerators and the like takes place in Ghana. Manufacturing of flexible foam for mattresses, cushions etc. accounts for 24% of the current regulated consumption, while the remainder includes halons for fire fighting equipment and carbon tetrachloride for various purposes. Refer to Figure 1.

7. From 1990 to 1991 Ghana experienced a sharp decline in the use of CFCs as blowing agents in the manufacturing of flexible foam, when one of the largest manufacturer switched to methylene chloride due to awareness of the ozone issue. However, another large manufacturer of flexible foam has from the beginning of 1992 increased consumption of CFC's heavily.

8. The use of CFC's as propellants for aerosols stopped around 1980. At that time both of the two aerosol manufacturers present switched to hydrocarbons.

Methodology of the Country Programme Preparation

9. The methodology for the preparation of the Country Programme involved an initial data collection mission to Ghana in May, 1992 with the purpose of collecting demand figures and other relevant data, discussing institutional and policy framework with industry leaders and government officials, and identifying project activities which may qualify for support from the Multilateral Fund. Costs estimates were then made for the different actions and projects based on consultations with specialists both in Ghana and abroad in the fields of refrigeration and flexible foam.

10. The draft Country Programme was discussed at a National Seminar. Following further consultations with industry representatives in the foam and refrigeration sectors the draft was reviewed by Task Groups set up by the National Committee on ODSs. The Fund Secretariat, at the request of the Government of Ghana, provided some guidance in the final revision of the draft.

Critical Assumptions

11. In order to estimate the total incremental costs of ODS phase-out in Ghana, the most plausible substitution techniques were identified and costed based on up to date information contained in the UNEP Technical Options Report of December, 1991 UNEP Refrigeration, Air Conditioning and Heat Pumps, Technical Options Committee Report of December 1991, and obtained from seminars on ODS alternative technologies held in Europe during February and March, 1992.

12. The analyses of alternative phase-out scenarios for the Ghanaian ODS consumption are

made with the aid of a computer-based linear programming model (CFCCOST). The model enables the user to analyze net incremental costs and benefits (in terms of ODS consumption phased-out over the period 1991-2010) of alternative phase-out scenarios. As it is an optimization model, the model automatically identifies the reductions and phase-out timing for each individual end user sector that minimizes total incremental costs subject to the Montreal Protocol requirements (or any potential tightening hereof) and the set of technical constraints.

13. The incremental costs estimated for Ghana comprise three elements:

- user costs, i.e. costs incurred at the level of manufacturers of ODS using products including incremental capital and operations costs, costs of re-training of personnel and research and development in connection with adaptation to ODS free technology, and the costs of technical assistance and support;

- consumer costs, i.e. incremental costs arising from forced early replacement of domestic refrigerators and extra costs of purchasing CFC free refrigerators instead of cheap second-hand CFC-12 refrigerators;

- government costs for institutional strengthening to ensure effective implementation of the Protocol.

14. The analyses in this report are based on a number of assumptions of which the most crucial are listed below:

- ODSs continue to be available in sufficient quantities to meet demand up to the year 2010 at current prices,

- unconstrained demand grows at a typical rate of 5-10% per year (for cold stores and flexible foam manufacturing the growth rate may temporarily be higher),

- a real discount rate of 10% is used in the analyses.

Costs and Benefits of Different Phase-out Scenarios

15. Two alternative phase-out scenarios have been analyzed:

(a) The allowable phase-out, i.e. a scenario, that postpones ODS phase-out until the latest possible date while keeping the country within the limits of the Montreal Protocol.

(b) An accelerated phase-out schedule, i.e. phase-out at a pace set by the availability of technology.

16. Scenario 1 is characterized by full utilization of the 10 year delay provision in the Protocol whereas in scenario 2, the transition to ODS substitutes is accomplished over the period 1992-1998 except for servicing of refrigeration equipment. It is, however assumed that control options

Figure 1. ODS Consumption in Ghana in 1991 by Type of ODS

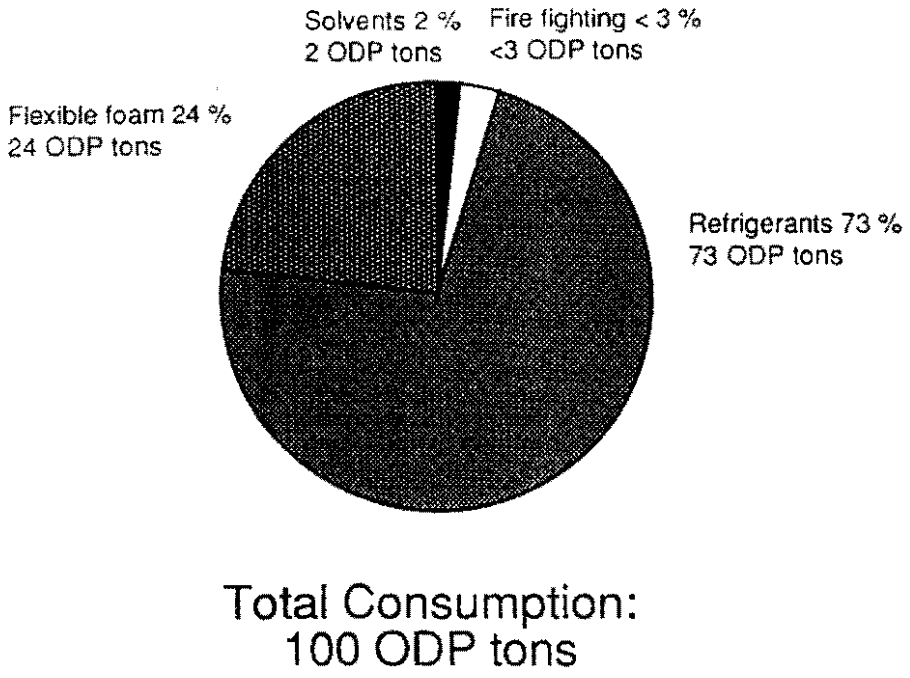


Figure 2. ODS Consumption in Ghana in 1991 by Major End-Uses

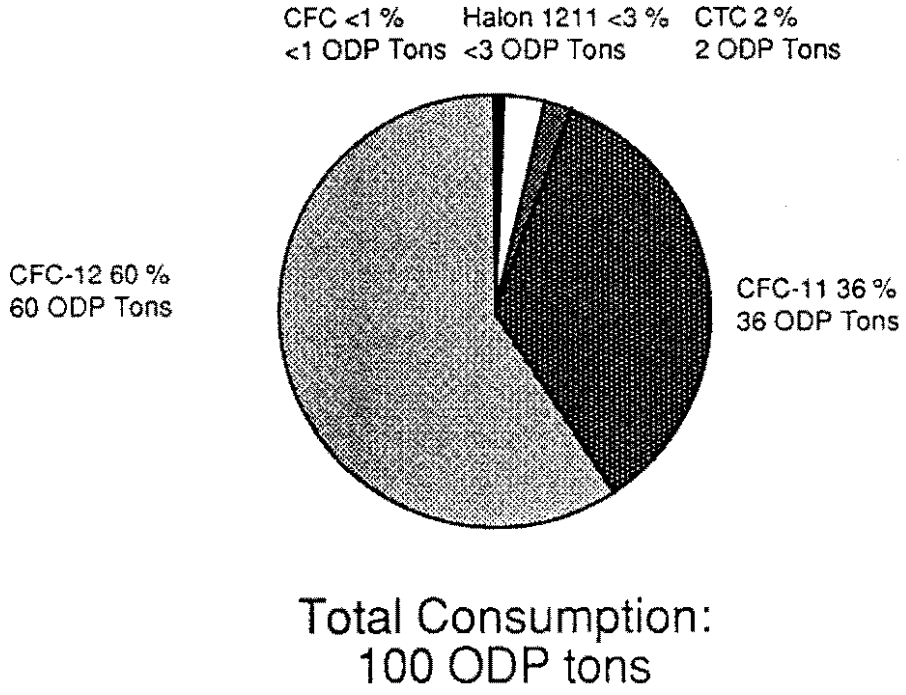
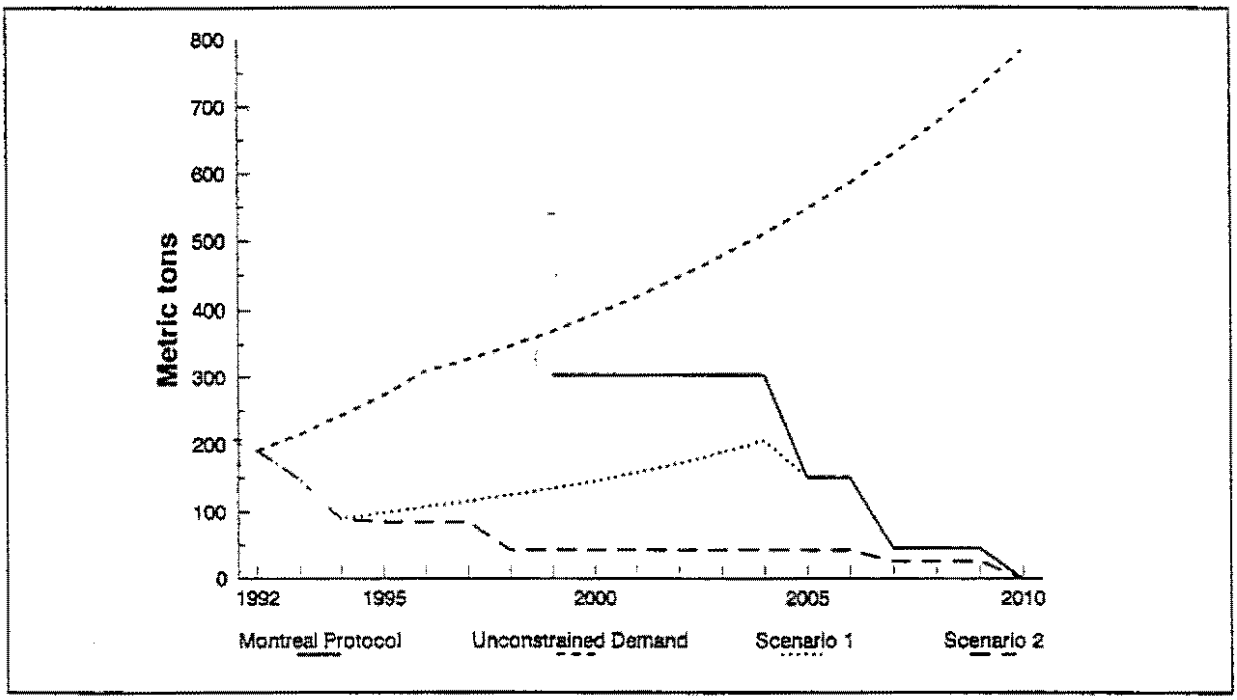


Figure 3. ODS Consumption under the Different Phase-out Schedules (1991-2010)



with zero or negative incremental costs are implemented regardless of Government regulations on ODS use and are thus included in both scenarios.

17. The ODS consumption profiles are shown in Figure 3 over the period 1991-2010 in each of the two phase-out scenarios together with projected unconstrained demand and the Montreal Protocol requirements.

18. Before the year 2000 the annual consumption increases in the allowable phase-out scenario, but by less than in the unrestricted situation. This reduction is caused by measures which imply no or minimal incremental cost such as replacing CFC-11 in flexible foam manufacturing by methylene chloride. In year 2000, the Montreal Protocol becomes binding for Ghana. The accelerated phase-out implies consumption well below the Montreal Protocol schedules during the whole period. The main reason for this deviation is the faster introduction of better service and maintenance procedures within the refrigeration sector. These are relatively cheap measures which can be initiated soon.

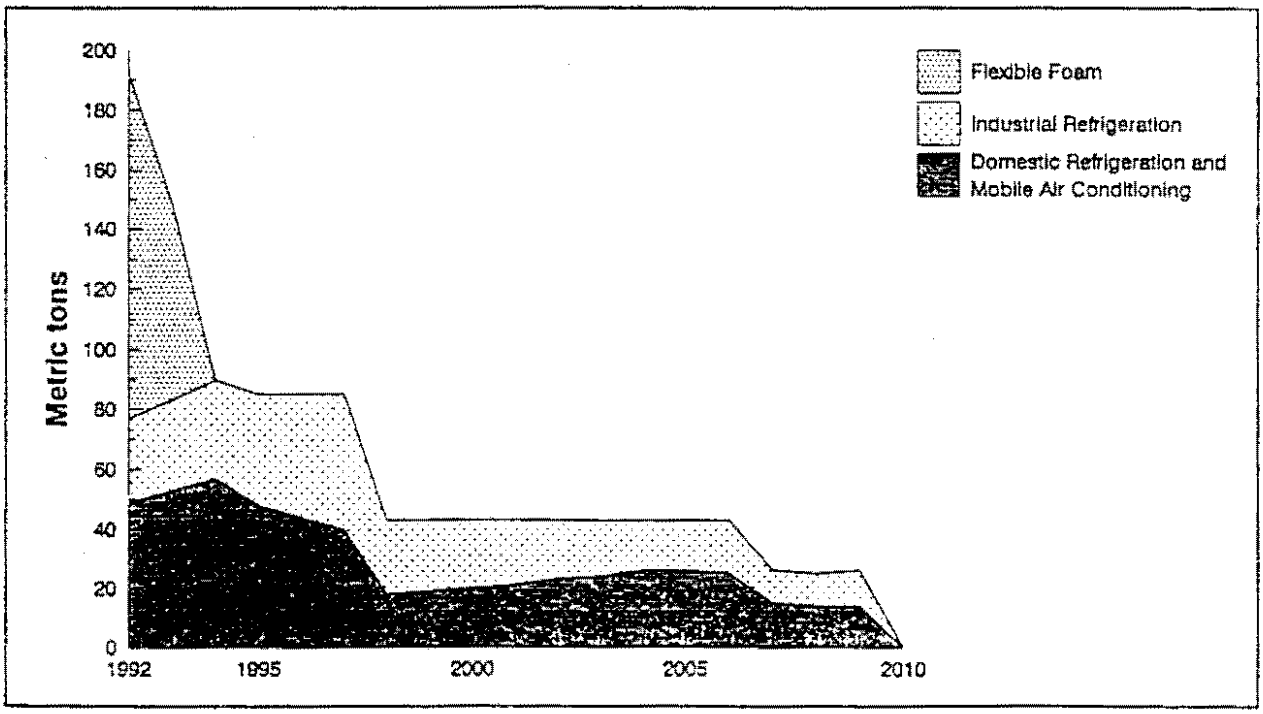
19. The total incremental costs are substantially higher in the allowable scenario as compared to the accelerated phase-out scenario. This difference is caused by high cost of premature scrapping of CFC based refrigerators. In addition to creating lower incremental cost, the benefit of the accelerated phase-out schedule is a reduction of 86% of the total unconstrained demand in Ghana from 1992 to 73% for the allowable phase-out schedule. As a result of this the cost per kilogramme ODS removed is only US $0.3 in the accelerated scenario compared to US $1.4 in the allowable scenario.

Table 1. Costs and Benefits of Alternative Phase-out Scenarios

Scenario	ODS use eliminated over the period 1992-2010 ODP tonnes (%of total un-constrained demand[1])	Incremental user costs Mill. US $ (1992 present value)	Incremental consumer costs Mill. US $ (1992 present value)	Total incremental costs Mill. US $ (1992 present value)	Discounted cost per kg ODS eliminated US $/kg (1992 present value)
1. Allowable phase-out	6,200 (73%)	0.5	8.4	8.7	1.4
2. Accelerated phase-out	7,300 (86%)	1.2	1.3	2.5	0.3

[1] Total unconstrained ODS demand over the period 1991-2010 is estimated at 8,500 ODP tonnes.

Figure 4. Recommended Phase-out Schedule by End User Sector



20. Scenario 2 is appraised to be the recommendable phase-out schedule for the following reasons:

Firstly, some of the major users of ODSs in Ghana have already taken actions independent of Government regulations to eliminate their use of ODS or formulated plans to do.

Secondly, it is possible that ODS producers in Europe and the USA will shut down their ODS production capacity in line with the bans on ODSs at their home markets. Although the Protocol allows for some continued production to meet the needs of Article 5 countries, it is not yet clear that this will be a commercially viable option for the producers. In any case, it is likely that CFC prices will rise making the accelerated phase-out even more attractive.

Thirdly, some of the measures necessary to comply with the Protocol like better servicing and maintenance procedures can be advanced without increasing the cost significantly.

21. These issues indicate that an accelerated phase-out is the most likely and the most desirable in Ghana.

Recommended Phase-out Strategy

22. The recommended phase-out schedule proposes a freeze in consumption compared to 1991 levels by 1993, a 50% reduction by 1995, 75% reduction by 1998, 85% reduction by 2007 and 100% reduction by 2010. This schedule is well ahead of Protocol limits and reflects the Governments objectives to minimize Ghana's consumption of ODS while at the same time minimizing the cost to Ghanaian industries and consumers. Furthermore, an accelerated phase-out is in accordance with the projects proposed for financing from the Multilateral Fund and in agreement with the aim of the Fund to provide incentives for early action.

23. The cost assessment of any phase-out schedule for Ghana depends on the assumptions made for domestic refrigeration. It is especially the high import of second hand refrigerators which causes cost estimates to be sensitive. The situation in Ghana is that the consumers will face considerable costs if they are restricted in buying second hand CFC-12 equipment and it will not likely be possible to buy CFC free appliances before around year 2006. Following the accelerated phase-out schedule it is recommended that the Government puts a ban on import of second-hand CFC refrigerators by the year 2006. However, if the supply of CFC-12 seems to be restricted during the period 2000-2010, the government should consider banning the import of CFC refrigerators at an earlier date.

24. The total incremental costs of the recommended phase-out schedule is estimated at US $2.5 million (net present value). The benefits is a reduction in total unconstrained ODS consumption of approximately 85% over the period 1991-2010. The planned consumption of ODSs until complete phase-out is shown in Figure 4 by the following applications:

- domestic and commercial refrigeration and mobile air-conditioning,

- industrial refrigeration, and

- flexible foam manufacturing.

Action Plan

25. The objective of the Action Plan is to phase-out the consumption of ODSs in Ghana in compliance with the Montreal Protocol as ratified by the Ghanaian Government, and in accordance with the recommended ODS phase-out strategy.

26. The Action Plan covers an initial period of a little over three years, the last quarter of 1992 to the end of 1995. The plan comprises the introduction of Government initiatives to effectively regulate and monitor the use of ODSs, and a series of proposed projects in the ODS end user sectors some of which are seen as prerequisites for implementation of the phase-out schedule.

Government Actions:

27. Two of the basic actions included in plan have actually already been initiated with effect from the beginning of 1992.

28. The relevant institutional framework for implementation of the Action Plan has been created by the establishment of the National Committee for ODS (NACODS), which includes representatives from key Government institutions as well as representatives for different user associations. The Committee shall advice the Environmental Protection Council (EPC) on all issues related to ODSs. Furthermore, under the EPC a special Ozone Office has been created. This Office acts as secretariat for the Committee and is envisaged to undertake a coordinating as well as a monitoring function in all further activities concerning the phasing-out of ODSs. Four Task Groups of the Committee on Programme Implementation, Refrigeration Sector, Foam Sector and Halon Sector will assist in the work of the office through periodic reviews of progress of actions.

29. A system for monitoring ODS use by substance has also been established. The system is based on the need for a clearance certificate to be obtained from the Ozone Office for import of ODSs before such import can be effected, and that the Customs, Excise and Preventive Service will supply copies of all import declarations concerning ODSs to the Ozone Office on the basis of the clearance certificate permitting the import. This will enable the Office to be in control of all imports passing through the ports and points of entry.

30. Other proposed Government Actions include:

Introduction of Regulatory Measures

The proposed regulatory measures include a schedule of bans on the use of ODSs for specific purposes at specifically given dates in accordance with the recommended phase-

out strategy; a special ODS tax on imports of all controlled substances to encourage initial substitution of ODSs in easily substitutable applications such as flexible foams; and tax exemptions for imports of ODS conserving or benign technology and non-ODS containing products. A local legal consultant will assist in preparing a full schedule of regulatory measures and draft regulations for consideration of the Government through the National Committee on ODS. An economist consultant will also assess the impact of these regulations and cost implications..

Introduction of a Certification Arrangement for Refrigeration Technicians

It is proposed to introduce a certification arrangement for refrigeration technicians having successfully completed the training programme proposed to be established as part of Project R-1. It is furthermore recommended that this certification arrangement is linked to the existing system in Ghana for approval of company operations by the Ministry of Industries, Science and Technology in collaboration with relevant industry associations. Thus, after a transition period of two years following a public awareness campaign, all workshops/companies operating or undertaking service on refrigeration equipment should, as a precondition for approval, provide documentation that their staff includes certified technicians.

Information Dissemination

Information campaigns which address consumers and small enterprises as well as industries using ODS should be launched.

Project Proposals:

31. Three projects are proposed for funding from the Multilateral Fund. In addition, a scheme to establish a "CFC-Bank" to offset a higher incremental cost of premature retirement of refrigerators is proposed for funding. Detailed descriptions of the project proposals are provided in Annex A.

Project IS-1: Institutional Strengthening for Programme Implementation

32. The purpose of the project is to strengthen the capability of the Environmental Protection Council to co-ordinate the implementation of Ghana's Country Programme to phase-out the use of ODSs.

Project R-1: Improved Servicing and Maintenance Within the Refrigeration Sector

33. The purpose of the project is to create a lasting improvement of the maintenance and servicing procedures currently being employed within the refrigeration sector in Ghana by training and supervisory programmes for technicians, introduction of recycling and strengthening of training institutions etc. The project will cover procedures related to all kinds of refrigeration equipment in use.

Project F-1: Elimination of the Use of Ozone Depleting substances in the Foam Sector - Technical Assistance for the Elimination of CFC-11 in the Flexible Foam Manufacturing Sector

34. The purpose of the project is to provide technical assistance to the industrial sector as well as the relevant government agencies to ensure speedy and cost-effective phase-out of the use of CFC-11 in the sector and to address health and environmental issues related to the use of methylene chloride as a substitute for CFC-11.

Budget and Financing of Activities 1992-1995

35. Table 2 gives a breakdown of costs of the Action Plan by components and by year of implementation. It is proposed that all the costs are incremental project costs to be funded by the Interim Multilateral Fund. The costs of the Government Action Plan proposed is covered by the Fund as an institutional support project. Once the incremental costs of the proposed projects are approved by the Multilateral Fund, appropriate funds handling mechanisms will be set up.

36. Total incremental costs of the Country Programme for the period 1992 - 1995 are estimated at US $1,152,000. This is made up of US $672,000 for project implementation and US $480,000 for the establishment of refrigerant security stock.

Table 2: Summary of Cost of Country Programme Activities (1992 - 1995) in US $

	1992	1993	1994	1995	Total
Institutional Strengthening including: - Regulatory Measures - Public Awareness	10,000	51,000	49,500	49,500	160,000
Improved Servicing and Maintenance within the Refrigeration Sector	12,000	301,000	62,000	52,000	427,000*
Elimination of the use of ODS in the Foam Sector	29,000	50,000	3,000	3,000	85,000
Sub-total	51,000	357,000	115,000	104,500	672,000
Refrigerant Security Stock		480,000			480,000
TOTAL	51,000	882,000	115,000	104,500	1,152,000

* The actual amount being requested for this sector is US $328,000, which takes into account US $99,000 within the UNDP Work Programme for 1991.

1. INTRODUCTION

Background

37. The Montreal Protocol is an international agreement to reduce the consumption of chlorofluorocarbons (CFCs) and halons. It was signed in Montreal, Canada in September, 1987 and has since been ratified by over 70 countries worldwide. In June 1990, the Protocol was amended to include other ozone depleting substances (ODSs), namely methyl chloroform (MCF- otherwise known as 1,1,1-trichloroethane) and carbon tetrachloride (CTC). The amended Protocol requires a complete phase-out of CFCs and halons by 2000 but developing countries with a calculated per capita consumption below 0.3 kg (Article 5 countries') are allowed a further 10 years to phase-out their use of ODSs. It should however be noted, that ODSs used in export products have to be phased-out by 2000 as the 10 year delay provision only applies to ODSs used to meet basic domestic needs.

38. The Montreal Protocol (as amended in June 1990) provides in Article 10 for a financial mechanism to assist Article 5 paragraph 1 countries' to comply with the control measures of the Protocol. Currently this has been implemented as the Interim Multilateral Fund (Multilateral Fund) to operate for a period of three years up to the end of 1993. The pledges to the Fund are up to US $240 million for the three year period 1991-93.

39. Ghana became a party to the Vienna Convention on 22 October, 1988 and ratified the Montreal Protocol on 24 July, 1989. Ghana also ratified the amendment to the Protocol on 22 July 1992. The per capita consumption of ODSs is estimated at 0.007 kg in 1991. Thus, Ghana qualifies under paragraph 1 of Article 5 of the Protocol for a ten year delay in the phase-out of ODSs, and the country is eligible for assistance from the Multilateral Fund.

Objectives

40. As a first step towards obtaining assistance from the Multilateral Fund, the Government of Ghana has decided to submit a Country Programme to the Fund's Executive Committee. The preparation of this Country Programme, reflects the commitment on the part of the Ghanaian Government to fulfil its obligations as a Party to the Protocol.

41. In accordance with Executive Committee's guidelines for Country Programme preparation, the report contains an examination of the pattern of ODS consumption in Ghana, a description of the institutional and policy framework within which the Country Programme will be implemented, analyses of alternative ODS phase-out scenarios, description of the recommended phase-out strategy including an estimate of the incremental costs of a complete phase-out, and an Action Plan for Government activities and proposed projects for which the Ghanaian Government seeks assistance from the Multilateral Fund.

42. The Country Programme serves as a key Government document for monitoring the progress being made in reducing ODS consumption in line with the recommended phase-out strategy, and periodically reviewing the effectiveness of the measures being taken.

43. The recommended phase-out schedule reflects the Government's objectives of not only minimizing consumption of ODSs, but also the cost to Ghanaian industries and consumers while subscribing to Montreal Protocol.

Status

44. The Environmental Protection Council (EPC) under the Ministry of Local Government took the lead in preparing the Country Programme. A UNEP-IE/PAC consultant, through two missions to Ghana in March and May 1992, assisted in organizing the preparation of the Country Programme initiating the data collection and participated in the discussion on the action plan. The total cost of preparation of the Country Programme is US $70,000.

45. The draft Country Programme was reviewed and adopted by the National Committee on ODSs and submitted to the Environmental Protection Council (EPC) for approval by the Government. The draft was finally submitted by the EPC to the Ministry of Local Government for approval by the Government.

Assistance Received

46. For the preparation of the Country Programme, EPC received financial assistance from the Government of Denmark through UNEP-IE/PAC. Besides a wide range of ODS using companies and distributors in Ghana, and Government officials representing the different ministries and agencies potentially involved in the implementation of the Action Plan provided valuable assistance in the discussion leading to the Programme.

2. ODS CONSUMPTION AND TRENDS IN GHANA

Recent Consumption of ODS

Data Collection

47. Estimates of Ghanaian ODS consumption are based on information collected in April-May 1992 by interviews with ODS distributors and consumers within the different ODS application fields (refrigeration, air conditioning, flexible foam manufacturing). Refer to Annex A for a list of company contacts.

ODS Consumption in 1991 by Substance

48. There is no production of ODSs in Ghana. These substances are all imported by a limited number of local distributors and directly by the ODS-using companies. The total import of CFCs has been estimated at approximately 97 tonnes in 1991 of which CFC-11 and CFC-12 account for almost 99%. Approximately 1 ton of CFC-115 is used in the composite refrigerant CFC-502 consisting of 49% HCFC-22 and 51% CFC-115. Refer to Table 2.1

49. Furthermore, the consumption of carbon tetrachloride was around 2 tonnes, and the consumption of transitional substances (HCFC-22) is estimated at 45 tonnes. No import and consumption of other CFCs, halons and methylchloroform has been registered in 1991. However, information with respect to the consumption of ODS for military purposes is not available. In terms of ODP weighted ODS consumption, the total has been estimated at 100 tonnes.

ODS Consumption by End-Use 1986-1991

50. The consumption of CFCs in Ghana has increased from 90 tonnes in 1986 to 97 tonnes in 1991. This limited increase is due to the fact that a relatively large CFC-consuming industry (flexible foam) has lately switched to other chemical compounds due to awareness of the ozone issue. If this substitution had not taken place, the CFC consumption in Ghana in 1991 would likely have been close to 175 MT. It should be noted that the Ghanaian economy as a whole over the latest years have enjoyed a relatively high rate of growth (growth in real GDP averaged around 5% yearly in the period 1986-1991).

51. The distribution of CFC's on end users in 1991 shows, that the refrigeration sector accounts for 73% of the total ODS consumption whereas the flexible foam sector constitutes approximately 24%. The use of CFCs in the aerosol sector has stopped completely, while the use in the solvents sector is negligible. Details on the growth of ODS consumption in Ghana are presented in Table 2.2.

Table 2.1. Estimated Consumption of ODSs in Ghana Broken Down by Substance, 1991 [1]

Substances controlled by the Montreal Protocol	Consumption (metric tons)	ODP factor	Consumption (ODP tonnes)
Annex A, Group I			
CFC-11	36	1.0	36
CFC-12	60	1.0	60
CFC-113	0	0.8	0
CFC-114	0	1.0	0
CFC-115	1	0.6	< 1
Subtotal	**97**		**97**
Annex A, Group II			
Halon 1211	< 1	3.0	< 3
Halon 1301	0	10.0	0
Halon 2402	0	6.0	0
Subtotal	**< 1**		**< 3**
Annex B, Group I			
Other CFCs	**0**	1.0	**0**
Annex B, Group II			
Carbon tetrachloride (CTC)	**1.6**	1.1	**2**
Annex B, Group III			
Methyl chloroform (MCF)	**0**	0.1	**0**
Total Controlled Substances	**100**		**100**
Annex C, Transitional substances			
HCFC-22	45	0.05	2
Other HCFCs	0		0
Total	**45**		**2**

[1] ODSs are not produced in Ghana. Consumption of ODSs equals imports.

Table 2.2. Estimated Development in ODS Use in Ghana, 1986-91 (in metric tonnes)

	1986	1989	1990	1991
Refrigerants				
CFC-11 [1]	30	6	0	12
CFC-12	45	55	55	60
CFC-115 in CFC-502	1	1	0	1
HCFC-22	50	60	40	45
Total CFC Refrig.	76	62	55	73
Total HCFC-22 Refrig.	50	60	40	45
Foam				
CFC-11	14	36	51	24
Total CFC Foam	14	36	51	24
Total CFC Aerosols	-	-	-	-
Solvents				
CFC-113 [2]	-	-	-	-
CTC	?	?	?	2
MCF	-	-	-	-
Total CFC solvents	?	?	?	2
Halons				
Halon 1211	< 1	< 1	< 1	< 1
Halon 1301	-	-	-	-
Total Halons	< 1	< 1	< 1	< 1
Total CFCs				
CFC-11	44	42	51	36
CFC-12	45	55	55	60
CFC-113 [2]	-	-	-	-
CFC-114	-	-	-	-
CFC-115	1	1	0	1
Annex A, Group 1 Total CFCs	90	98	106	97
Annex A, Group 2 Total Halons	< 1	< 1	< 1	< 1
Annex B, Group 2 Total CTC	?	?	?	2
Annex B, Group 3 Total MCF	-	-	-	-
Annex C Total HCFCs	50	60	40	45

? Information is not available.

1) The variation in consumption observed may partly be due to variations of stocks at distributors as well as consumers.

2) An import of 1 ton of CFC-113 was registered for 1987.

Source: Mission estimate 1992.

INDUSTRY STRUCTURE

Overall Characteristics of the ODS Related Industry in Ghana

52. The following main observations characterize the ODS related industry:

(a) All ODSs are imported mainly from Europe. However, in recent years import from Nigeria (legal as well as illegal) has been important due to significant price differences for CFCs in bulk between Ghana and Nigeria. Chemico Ltd. (an associate of ICI (UK) and L'Air Liquide (a daughter company of Galex Ltd. (France) are the dominant distributors serving mainly the refrigeration sector but a number of other Ghanaian companies obtain supplies from other sources via trading companies in Germany, UK etc. The manufacturers of flexible foam buy ODSs directly from their suppliers of chemicals in Europe.

(b) Manufacturing of flexible foam for mattresses, cushions and similar applications is the only manufacturing process employing ODSs existing in Ghana. No export of flexible foam products take place. Some manufacturers within the flexible foam industry have already or are in the process of substituting CFC-11 with methylene chloride. The two existing aerosol manufacturers switched to hydrocarbons for several years ago due to awareness of the ozone issue.

(c) The refrigeration sector accounts for approximately 73% of the total consumption of controlled substances. The sector includes applications like servicing and to some extent also installation of domestic appliances, car air-conditioning systems, miscellaneous commercial and industrial refrigeration equipment together with large factory chillers. Of the total consumption within the refrigeration sector, approximately 45 MT equalling 62% is related to consumer products like domestic appliances and car air-conditioning systems. The remainder is related to the various commercial and industrial applications.

(d) All kinds of refrigeration equipment are imported including compressors and other materials necessary for installation of cold stores, air conditioning systems etc. It should be noted that insulation of cold stores etc. is based solely on locally manufactured EPS foam sheets which do not contain ODS.

(e) There is no significant recovery or recycling of ODS.

53. Table 2.3 provides an overview of the ODS consumption in Ghana for 1991 by user sector and application. A brief description of each user sector is given below.

Use of ODS as Refrigerants

54. In 1991 the consumption of ODS refrigerants in Ghana totalled about 60 tonnes of CFC-12, 12 tonnes of CFC-11, one ton of CFC-115 in the composite refrigerant R-502 (51.2% CFC-

Table 2.3. Estimated ODS Consumption in Ghana by Use and Application, 1991

User sector	Substance	Application	Consumption (metric tons)			
REFRIGERATION			Annex A, Group I	Annex A, Group II	Annex B, Group II and III	Annex C
Domestic	CFC-12	Servicing of refrigerators and freezers	20			
	HCFC-22	Servicing of refrigerators and freezers				10
Commercial	CFC-12	Servicing of display cabinets	2			
Industrial	CFC-12	Installation and servicing of cold stores	10			
	CFC-12	Servicing of refrigerated containers and trucks and refrigeration plants onboard fishing vessels	2-3			
	CFC-115	Installation and servicing of cold stores (R-502 plants)	1			
	HCFC-22	Installation and servicing of cold stores				10
	HCFC-22	Installation and servicing of refrigeration plants onboard fishing vessels				5
AIR CONDITIONING						
Cars	CFC-12	Installation and servicing of car air conditioners	25			
Building	HCFC-22	Servicing of room air conditioners				12
	HCFC-22	Installation and servicing of central building air conditioners				8
Industrial	CFC-11	Servicing of central factory chillers	12			
	CFC-12	Servicing of central factory chillers	< 1			
FOAM	CFC-11	Manufacturing of flexible foam	24			
SOLVENTS	CTC	Various minor applications			2	
FIRE FIGHTING	Halon-1211	Portable/transportable fireextinguishers		< 1		
TOTAL ODSs			97	< 1	2	45

115 and 48.8% HCF-22) and 45 tonnes of HCFC-22. The different sub-applications comprise:

- servicing of domestic appliances and display cabinets (CFC-12);
- installation and servicing of car air-conditioners;
- installation and servicing of industrial refrigeration and air conditioning systems including cold stores, ice plants, refrigerated trucks and containers, fishing vessels and central factory chillers (CFC-11, CFC-12, CFC-115 and HCFC-22), and
- servicing of room air conditioners and installation and servicing of medium and large sized central air conditioners (HGCFC-22).

Servicing of Domestic Refrigerators and Display Cabinets

55. Based on import statistics the number of domestic refrigerators and freezers in use in Ghana can be estimated to be approximately 100,000, which corresponds to refrigerator ownership by about 2% of all households. A dominant part (estimated 75%) of these units has been imported as second hand units from Europe. In 1991 it is estimated that approximately 20 MT CFC-12 were used to service these units and to repair the imported second hand units. The number of display cabinets for commercial purposes are roughly estimated to around 5000 with an estimated consumption of CFC-12 for servicing of approximately 2 MT.

56. Domestic and commercial refrigerators are serviced by a large number of workshops located mainly in the larger cities. The total number of workshops within this field are estimated at approximately 750. Besides servicing domestic and commercial appliances these workshops do also service car and room air-conditioning equipment and miscellaneous medium sized cooling systems (reference is made to the next paragraphs).

57. The large consumption of CFC-12 for servicing of domestic and commercial appliances may be explained by the relatively old age (average is estimated to 10-15 years) of most of the units in use and the need for more frequent servicing but also by the procedure to use CFC-12 for recharging of the refrigeration circuit as well as for purging and leak testing. The larger workshops prefer to use nitrogen or HCFC-22 for purging and leak testing. However, frequent shortages of nitrogen as well as of CFC-12 and HCFC-22 force the workshops to use whatever compound is available on the market. The logistics behind these shortages have not been identified.

Installation and Servicing of Medium and Large Cooling Systems

58. Medium and large commercial and industrial cooling systems comprise:

- cold storage and food processing in the fruit and vegetable sector, and the dairy, meat and fishing and beverage industries,

- refrigerated trucks and containers, and refrigeration plants onboard fishing vessels

- central chilling systems for the textile manufacturing and cocoa processing industries.

59. The systems are generally imported and installed in co-operation with Ghanaian companies, which also undertake after sale, maintenance and service. A number of companies are involved, including:

- CFAC Ltd., and
- Mandilas Ghana Ltd.

60. However, larger industries especially within textile manufacturing and cocoa processing often prefer to undertake own import of equipment and materials and carry out installation and maintenance using own technicians or specialists from abroad.

61. Central chilling systems are mainly based on CFC-11. The number of plants installed in Ghana is in the range of seven to ten, of which at least one plant is based on CFC-12.

62. Refrigerated trucks and containers operates on CFC-12, while refrigeration plants onboard fishing vessels uses CFC-12 as well as HCFC-22. The number of trucks operating in Ghana is in the range of 100-150 while the number of fishing vessels using ODSs comes up to around 20. All refrigerated containers are owned by international shipping companies and are only being serviced in Ghana.

63. Cold stores vary from small container based stores (installed in ordinary 20ft or 40ft containers) to large industrial plants with a capacity of approximately 2000 MT and may be more. Of the small container-based cold stores presently 600-700 is operated in Ghana mainly based on CFC-12 (approx. 70%) while the remainder are using HCFC-22. Due to the ongoing national programme of electrification of rural areas the number of these cold stores is increasing tremendously (300-400 new units yearly) since this type of cold store is most appropriate for villages and smaller cities. Larger cold stores are based mainly on HCFC-22 although a few plants are using R-502.

64. A significant part of the large cold stores and refrigeration plants onboard fishing vessels operated in Ghana are based on the use of ammonia as refrigerant. However, for safety reasons and due to problems in ensuring adequate maintenance standards of ammonia plants a trend away from ammonia towards HCFC-22 can be observed.

Installation and Servicing of Air Conditioning Systems

65. Of the current stock of approximately 100,000 vehicles in Ghana, an estimated 20-30% are equipped with air-conditioning systems. Based on the current practices of major repairs every two to three years and topping up several times yearly besides that CFC-12 is used for cleaning, leak testing as well as recharging the consumption in 1991 has been estimated at 25 tons.

66. Building air-conditioning which comprises room air-conditioning units as well as medium to large scale central building systems is based solely on HCFC-22. Until a few years ago room air-conditioning units was manufactured in Ghana. However, after import was made free in 1987 local production has stopped. Import today is undertaken by numerous dealers and the demand is high. Current stock is estimated to be in the range of 50,-100,000 units, dominantly of the block type with a content of HCFC-22 of approximately 1 kg. The consumption for servicing is roughly estimated at around 15 tons HCFC-22 yearly.

67. The current number of medium sized central building systems is estimated to be 300-500, of which the dominant part is a 20 t unit adequate for a five bedroom house with a content of HCFC-22 of around 40 kg. The current number of large scale systems meant for office buildings etc. is estimated. The consumption of HCFC-22 for installation and servicing of central building air-conditioning systems is roughly estimated to 8 tonnes yearly. Installation and servicing of medium and large sized systems are undertaken mainly by the two companies, CFAO and Mandilas, who are dominating with respect to large scale cold stores as well.

Use of ODS as Foam Blowing Agents

68. In 1991 the consumption of CFC-11 as blowing agent for manufacturing of flexible foam was about 24 tonnes. A number of manufacturers of flexible foam exist in Ghana. However, only three manufacturers were using CFC. Of these three manufacturers one has switched from CFC to methylene chloride in 1991 due to awareness of the ozone issue, while another has planned to do the same in 1992. The third manufacturer has, however, due to a need for manufacturing of low density foam qualities started using CFC blowing agents in 1991 and is increasing the consumption of CFC heavily from 1991 to 1992. If the change of blowing agent had not taken place the consumption of CFC-11 would have been more like 100 tonnes in 1991 and probably around 150 tonnes in 1992.

Use of ODS as Aerosol Propellant

69. Two companies produce common aerosol products in Ghana, viz:

- SC Johnson Wax, and
- Shell Ltd.

70. Both of these companies have replaced CFCs with iso-butane. The change took place in the early 1980s when the initial scientific assessments pointed to CFCs as a cause of ozone layer depletion.

71. Although no statistics are available it is commonly recognized that the change from CFCs to hydrocarbons as the propellant in aerosol products has resulted in a number of serious casualties yearly due to lack of literacy skills and awareness among the poorly educated part of the population (aerosol products are put too close to fire places etc.).

Other Uses of Regulated ODS

72. In addition to the main applications of ODS discussed in the previous sections, a number of minor uses have been noted. These uses have not been investigated in detail at the present stage. It is estimated that each use accounts for less than 2% of the total ODS consumption, and the total for these various applications is in the order of < 5% of the total consumption.

Halon Fire Extinguishing Agents

73. Transportable fire fighting equipment based on halon 1211 is available at Kotoka International Airport in Accra. Furthermore, an import of portable fire extinguishers presumably also containing halon 1211 is taking place. No stationary equipment based on halon-1301 seems to have been installed.

74. While no import of halons in bulk have been noted in 1991, a minor import of halon 1211 for refilling of existing equipment took place in 1988. A limited import and consumption for military purposes is likely, although no precise information is available.

Other Uses

75. A limited quantity of CTC is imported (approximately 1.6 tonnes in 1991) for laboratory purposes and for use in the oil industry. While no import of CFC-113 and MCF have been noted in 1991, a minor import of CFC-113 (one tonne) was noted back in 1987.

76. It is likely, that there might be a limited consumption of decreasing/cleaning agents for military purposes, but no information in this regard is available.

UNCONSTRAINED DEMAND FORECAST

Factors Determining Demand for ODSs

77. In order to assess the net incremental costs to Ghana of the Montreal Protocol, it is necessary to forecast ODS demand up to the year 2010 as if the Montreal Protocol did not exist. It is therefore assumed that:

- ODSs are not regulated; and
- unconstrained quantities of controlled substances continue to be available from existing sources, at current prices.

78. The unconstrained demand for ODSs is derived from the demand for products that contain or are made with ODSs and from the need for servicing of refrigeration and air conditioning equipment which in turn is determined by such factors as

- population growth rate,

- income growth rate,
- sector plans (expected sector specific growth rate),
- present state of market saturation for consumer goods, e.g. refrigerators, aerosol products and mattresses, and
- the quality of consumer products (service needs and standards).

79. These factors together with sector specific information are used in the following section to project the unconstrained ODS demand up to year 2010.

80. It should, however, be noted that the future demand for ODSs in Ghana also depends on a number of external factors which are likely to affect demand - regardless of Ghana's own national ozone policy, including:

- the development in the prices of ODSs, and
- the awareness regarding available alternative technologies.

81. All these factors result from the international regulation of ozone depleting substances and have an impact on the economic prospects for Ghana. In the current situation, some ODS manufacturers like HOECHST and Du Pont are reducing their production levels at a faster rate than stipulated in the Protocol, and their prices are, consequently, rising. Other ODS producers still supply ODS at unconstrained prices but this may change as ODS are phased-out in the developed countries. It is difficult to project the development in ODS supply and prices. Although it can be expected that some of the world's ODS producers will maintain a level of production that is sufficient to meet the needs of developing countries up to the year 2010, there is a risk that prices will increase considerably.

82. Alternative technologies are to some extent already available on the Ghanaian market (HCFC-22, ammonia, etc.) at competitive prices. The transition to these alternatives, therefore, depends mainly on the consciousness about the ozone problem. New technologies such as HFCs and HCFCs can be expected to be commercially available in 2-3 years time. Thus, technology should not be a major constraint for an early ODS phase-out (however, doubts have been raised whether the initial production capacity to be installed for manufacturing of the new compounds will be sufficient to fulfil the needs also of the developing countries). Apart from this issue the main constraints for ODS phase-out in Ghana seem to be the cost consequences and also to some extent lack of human resources and awareness.

Unconstrained Demand by Major End-User Sectors, 1991-2010

83. Table 2.4 sets out the basic growth and other assumptions underlying the unconstrained demand forecast. Two sub-periods are considered:

- 1991-1997, within which growth rates are based on available forecasts for GDP and consumption in the different user sectors; and

- 1997-2010, within which the growth of GDP is assumed to continue at the same rate as for 1991 to 1997 while for some user sectors a more conservative growth scenario has been adopted.

84. The projections for the second period are very uncertain, given the long time perspective. The impact of alternative growth assumptions on net incremental costs is, therefore, analyzed in Chapter 3.

Refrigeration and Air Conditioning Sector

85. Based on import statistics from the recent years the stock of domestic refrigerators is expected to increase at a rate of approximately 10% yearly. At present, only some 2% of Ghanaian households own a refrigerator. It can, therefore, be expected that this demand rate will continue over the whole period from 1991 to 2010. The demand for servicing of domestic refrigerators is based on the assumption that an average around 20% of the stock will be serviced yearly. This high rate is based on estimates by refrigeration workshops in Ghana and is justified by the fact, that the dominant part of refrigerators imported is second hand units from Europe.

86. In the case of CFC-12 cold stores the current rate for installation of new units is very high (around 50% of the existing stock). It is assumed here, that this very high rate will soon phase-out and that a rate of an average 15% will be a more realistic forecast for the period 1991-2010.

87. For Mobile air-conditioning is assumed a growth rate in ODS consumption of approximately 10% yearly for 1991-1997, while a more conservative estimate of 5% yearly is used for the period 1997-2010. The growth rate for 1991-1997 equals the current yearly increase in the stock of air-conditioned vehicles in Ghana.

88. For other applications within the refrigeration and air-conditioning sector the growth rate is assumed to equal the general growth of the economy.

Foam Sector

89. Despite a still competition on the market for flexible foam in Ghana, it seems that manufacturers who are able to produce low density foam qualities are increasing their share of the market, thus increasing the demand for auxiliary blowing agents. Based on consumption forecast from the leading manufacturing companies an average growth rate of 15% has been assumed for the period 1991-1997. However, the total market is limited and it is likely that the growth for the period 1997-2010 will be reduced to a rate equal to the general GDP growth rate.

Other Sectors

90. For other sectors, i.e. fire extinguishers and the use of CTC, it is assumed that the

Table 2.4. Summary of Growth and Other Assumptions

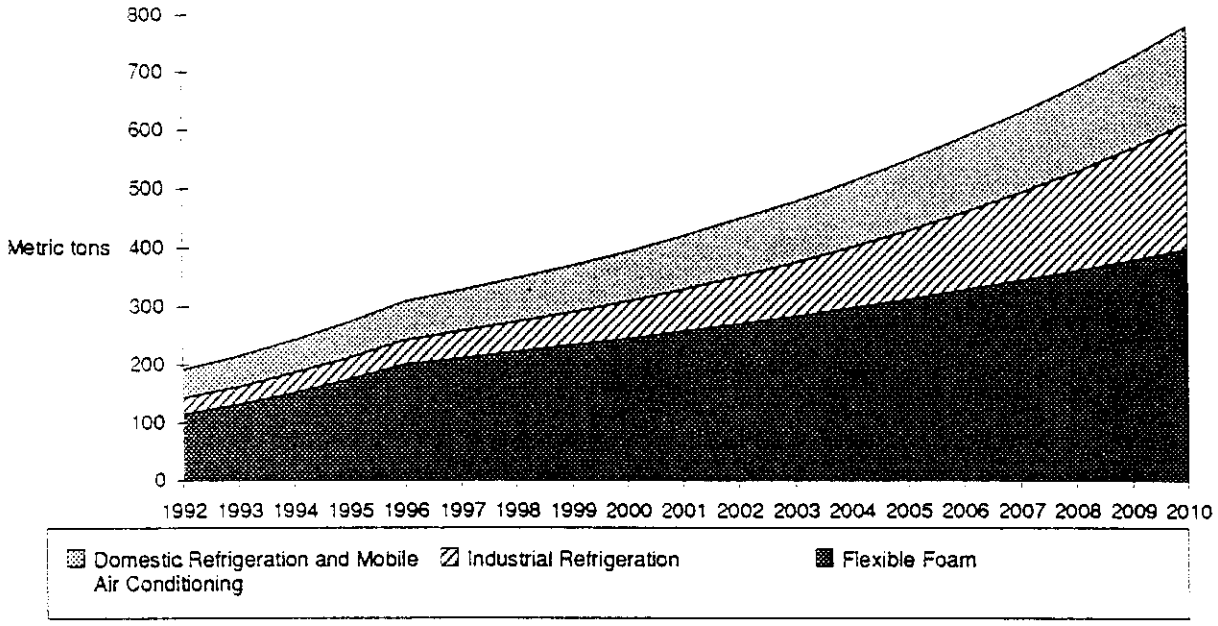
Area/user sector	Application	Unconstrained CFC use 1991 (metric tonnes)	Growth and other assumptions	Period
Population			15 millions [2] 2.7% average annual growth (as current growth rate)[2]	1991
Households			3.1 million	1991
Real GDP			5% average annual growth [3] 5% average annual growth GDP/capita: USD 410	1991-1997 1997-2010 1990
REFRIGERATION AND AIR CONDITIONING				
Domestic refrigeration	Servicing	20	10% average annual growth 10% average annual growth Average lifetime	1991-1997 1997-2010 20-25 years
Commercial refrigerators	Servicing	2	5% average annual growth 5% average annual growth Average lifetime	1991-1997 1997-2010 15-20 years
Cold stores (CFC-12)	Installation and servicing	10	15% average annual growth 15% average annual growth Average lifetime	1991-1997 1997-2010 20-25 years
Other industrial refrigeration and air conditioning	Installation and servicing	15-17	5% average annual growth 5% average annual growth Average lifetime	1991-1997 1997-2010 25 years
Mobile air conditioning	Installation and servicing	25	10% average annual growth 5% average annual growth Average lifetime	1991-1997 1997-2010 10 years
FOAM [1]	Manufacturing of flexible foam	100	15% average annual growth 5% average annual growth	1991-1997 1997-2010
CTC	various minor applications	1.6	5% average annual growth 5% average annual growth	1991-1997 1997-2010
HALONS	Fire extinguishers	< 1	5% average annual growth 5% average annual growth	1991-1997 1997-2010
TOTAL ODSs		176		

1) Unconstrained consumption of CFCs in the manufacturing of flexible foam differs from the actual consumption in 1991 because part of the foam industry has already shifted to alternative blowing agents (methylene chloride).

2) Source: Situations- and perspektivanalyse - Ghana. DANIDA, Copenhagen 1990

3) Source: Ghana - Progress on adjustment, Report no. 9475 GH, 1991

Figure 2.2. Forecast of Unconstrained ODS Demand 1991-2010



consumption will grow at rate equal to the general GDP growth rate.

Institutional Framework

91. This section briefly describes the responsibilities and capabilities of institutions which are seen as key players in the successful implementation of a national policy to phase-out the use of ODSs in Ghana. The key institutions have been contacted and visited.

Government Agencies

The Environmental Protection Council (EPC)

92. The EPC was created in 1974. EPC comes under the Ministry of Local Government, and is headed by its own Executive Chairman. The main responsibilities of EPC are:

- to advise the Government on environmental matters related to the social and economic activity of the country;
- to enlighten the public on environmental issues and create awareness on environmental problems;
- to undertake and promote research into environmental problems;
- to establish standards on environmental quality to be observed by Ghanaian industries;
- to undertake and approve environmental impact assessment (EIA) of all new industrial projects before project implementation is permitted;
- to advise the Government and industries on the best ways of disposing wastes likely to create environmental hazards, and
- to represent Ghana on environmental matters in a international context.

93. The EPC has no enforcement powers itself, but will act by giving recommendations to other Government Ministries and bodies.

94. Under the EPC a National Committee on ODS has been formed. This Committee serves as an advisory body to EPC on all ODS related matters and is responsible for giving advice on, i.a. policy requirements, legislation, programmes of action, research, institutional strengthening and awareness campaigns in this regard. The Committee is headed by the Executive Chairman of EPC and includes representatives from:

- Ministry of Agriculture;
- Ministry of Industries, Science & Technology;
- Ministry of Trade and Tourism;
- Meteorological Services Department;
- Department of Geography and Resource Development;
- Council for Scientific and Industrial Research;
- Faculty of Science, University of Ghana;
- Faculty of Engineering, University of Science & Technology;

- Factories Inspectorate Department;
- Ghana Association of Industries;
- National Refrigeration & Air Conditioning Workshop Owner's Association (NARWOA);
- Friends of the Earth, and
- UNDP-Ghana.

95. Under the EPC a special Ozone Office has, furthermore, been established. This office has a staff of two professionals on a permanent basis and two more professionals on a part time basis. The office deals with all activities related to ODS including monitoring of consumption and international activities. The office acts as secretariat for the National Committee for ODS and is envisaged to undertake a coordinating as well as monitoring functions in the future activities related to the phasing-out of ODSs. The Office reports directly to the Executive Chairman of EPC.

Ministry of Finance and Economic Planning (MFEP)

96. MFEP has the legislative power with respect to taxes and tariffs and must be involved if any financial incentives/disincentives concerning ODSs and ODS related equipment (e.g. recycling equipment) are introduced. In collaboration with the Ministry of Trade and Tourism MFEP also holds the power of banning import of certain items and commodities.

Customs, Excise and Preventive Services (CEPS)

97. CEPS is placed under MFEP but is an autonomous institution. CEPS is responsible for enforcing duties and taxes and preventing illegal imports of goods. Furthermore, the monitoring system for ODS consumption introduced in Ghana is based on the fact, that CEPS will provide copies of all import declarations concerning ODS to EPC.

Ministry of Industries, Science & Technology

98. The Ministry of Industries, Science and Technology is the chief government agency responsible for relations between Government and industry. The Ministry is inter alia responsible for formulation of industrial policies, preparation of national development plans, promotion of new industrial investments, control and regulation of existing industries and the information of science and technology plans. More specifically the Ministry is in charge of permitting establishment and operations of all new companies in Ghana and, furthermore, has the power of banning the use of certain substances including ODS.

99. The Ministry is represented on the National Committee for ODS and naturally has a central position in the work of implementing the National Action Plan for phasing-out of ODS.

Ministry of Agriculture

100. The Ministry of Agriculture among other activities is responsible for food production and

distribution within Ghana, cocoa export and fishery, all of which are areas essential for the Ghanaian society and highly depending on the use of cooling facilities. The Ministry is represented on the National Committee for ODS.

Factory Inspectorate Department (FID)

101. FID under the Ministry of Mobilization and Social Welfare is responsible for ensuring the safety of Ghanaian workers by monitoring the conditions for occupational health and safety at all workplaces over the country. To the extent that the phasing-out of ODS's will rely on the use of more toxic compounds, e.g. ammonia, HCFC-123 and methylene chloride, it is essential that appropriate precautions are taken. Such precautions may include general and personal safety devices as well as procedures to ensure that plants as well as safety devices are properly operated and maintained. In this regard FID is in a key position.

102. At present, the Factory Inspectorate is clearly understaffed with only 20 professionals to monitor all workplaces all over Ghana. It is also noted, that the Factory Inspectorate has no special expertise with respect to ammonia plants. This is seen as a major problem, and the institution must be strengthened in order to ensure that the implementation of the Montreal Protocol will not increase the health and safety risks for Ghanaian workers.

Other Important Government Institutions

103. Other important institutions include training centres presently involved in training of refrigeration technicians, including:

- The three Polytechnical Institutes situated in Accra, Kumasi and Takoradi.
- The National Vocational Training Institute situated in Accra, and
- The Maritime Academy between Accra and Tema, whose activities are focused especially on the needs of the fishing industries.

104. These institutions should play an important role in the implementation of the proposed training projects within the refrigeration section. The lack of qualified refrigeration technicians is a constraint cited by many of the companies and institutions visited.

Industry Associations

Association of Ghana Industries (AGI)

105. AGI is the main association for manufacturing companies in Ghana. It is a voluntary association with the primary objective of promoting the interests of Ghana industries with respect to legislation and other Government measures affecting industrial operations in Ghana. AGI represent more than 1500 member industries.

106. AGI is a member of the National Committee for ODS and could play a key role in the implementation of the National Action Plan for the phasing-out of ODS.

National Refrigeration and Air Conditioning Workshop Owners Association (NARWOA)

107. NARWOA is the key association embracing air conditioning and refrigeration workshops. The current number of workshops which are members of NARWOA comes up to 719 thereby NARWOA represents approximately 95% of all workshops within the fields of air-conditioning and refrigeration in Ghana. The main objective of NARWOA is to support the members with respect to professional, economic as well as social issues. NARWOA has established an apprenticeship arrangement for refrigeration technicians covering five years of training at a certified workshop followed by a discharge test. Apprentices, who successfully complete the test will be awarded a certificate issued by NARWOA. This certification arrangement will be strengthened with the participation of the Ministry of Industries, Science and Technology.

108. NARWOA is a member of the National Committee for ODS and is already active in creating awareness among the member workshops with respect to the need for improved servicing practices.

Non-Government Organizations

109. Except for the local branch of the international environmental association "Friends of the Earth", no other environmental associations seems to be active in Ghana. Environmental NGOs may typically play a key role in information campaigns aimed at increasing the awareness of the ozone problem among the general public.

International Organizations

Economic Community of West African States (ECOWAS)

110. ECOWAS is the international body for economic co-operation between West African states and is dealing mainly with policy issues. ECOWAS could be an important forum for co-ordination of ODS activities among the West African states since the impact of actions introduced in Ghana will naturally be affected by the situation in neighbouring countries, of which not all for the time being are parties to the Montreal Protocol.

Policy Framework

Government

111. Ghana gained independence in 1957. The period from 1957 to 1991 has been characterized by several regimes varying from republics with democratically elected governments to military rules. The present regime - the Provisional National Defence Council (PNDC) - took over power in 1981 in order to stop the widespread corruption and to restore the political, social and economic order of the country. A new constitution reintroducing democracy in Ghana was

approved by general public referendum in April 1992.

Economic Situation

112. In 1990, according to estimates by the World Bank, Ghana's gross domestic product (GDP), measured in current prices, was US $6,150 million, equivalent to US $410 per capita. Ghana's economy has experienced an average annual growth in real GDP of approximately 5% since 1983 when the Economic Recovery Programme (ERP) was introduced. A continuous growth in real GDP of about 5% per year is expected. Inflation over the past four years has averaged around 28% with a declining trend. The inflation rate in 1991 was 18%. As part of the Economic Recovery Programme the economy is gradually being liberated and the government involvement is being reduced.

113. Export earnings accounts for around 20% of GDP. The main source of earnings is cocoa, which is exported in its raw form and constitutes around 40% of the total export earnings. The balance is made of export of minerals (gold, bauxite, diamonds, manganese etc), timber and surplus electricity.

Taxation System and Incentives

114. Import duty rates range between 0 and 35%, while sales tax rates in general falls within the interval 0-25%. In addition certain items have an excise tax. The highest rates are imposed on luxury commodities such as air conditioning units.

115. Exemptions from import tax may be granted for equipment necessary to facilitate the phasing-out of ODS's. The decision would have to be taken by the Ministry of Finance and Economic Planning based on recommendation from the Environmental Protection Council.

116. In Ghana, the main commercial policy instruments currently in use to control of imports are:

- Customs duties, and
- Import surcharges.

117. Policy instruments like quantitative restrictions and import licensing could, however, be reintroduced if the need arose.

Government and Industry Responses to the Protocol

Montreal Protocol Status

118. Ghana became a party to the Vienna Convention on the 22 October, 1988 and ratified the Montreal Protocol on 24 July, 1989. Representatives of the Government have attended all major Montreal Protocol meetings to date. Ghana is eligible for assistance from the Interim

Multilateral Fund as it is classified as a developing country, and its per capita consumption of ODSs is only 0.0006 kg, well below the 0.3 kg/capita limit allowed for Article 5 countries.

Government Response to the Protocol

119. The EPC has established a monitoring system for the consumption of ODSs in Ghana and will report regularly to UNEP. The Ozone Office within EPC and the National Committee on ODS started their activities early 1992.

120. With the preparation of a Country Programme, policies, strategies and action programmes have been formulated to achieve the objectives of the Protocol.

Industry Response to the Protocol

121. The awareness of the ODS issue varies considerably among the ODS users in Ghana. Except for the aerosol manufacturers and some of the flexible foam manufacturers no users have adopted the ODS issue as a priority issue and adjusted their production facilities accordingly. A wait and see position is prevalent, since the costs of transition may be high and alternative technologies are not yet commercially available for all end users.

122. In the refrigeration sector the workshop owners association (NARWOA) are well aware of the ODS issue and are trying to promote better servicing practices. However, their efforts in this regard is hampered by lack of resources and limited access to up-to-date knowledge. When it comes to the industrial users some of them are well aware of the ODS issue while others are not. Common for the industrial users is a wait and see position, and very little consideration has presently been given to, what to do when ODS's are no longer available. Industrial users also complain about a lack of trained refrigeration technicians with respect to ODS systems as well as ammonia systems. However, to some extent this lack of technicians may also be due to lack of willingness/ability among the companies to pay salary levels, that will attract well-trained technicians. The trend of moving from ammonia plants towards HCFC-22 for larger plants based on the safety problems often related to ammonia plants may find its roots in the widespread attitude of not paying attention to preventive maintenance but adhering to problems first at the time of the accident.

123. Among the flexible foam manufacturers the level of awareness of the ODS issue varies considerably as is seen from the varying attitude to the use of CFC (reference is given to section 2.2.3). However, the choice made by the manufacturer currently increasing the consumption of CFC is besides the need for low-density qualities based on, that test productions with methylene chloride did not give satisfactory results.

124. The fact that Ghanaian aerosol producers are well aware of the Montreal Protocol as they have eliminated the use of ODS's long before the Protocol was actually established. However, the issue of consumer's safety is still of much concern to the Government (reference is given to section 2.2.4).

3. IMPLEMENTING PHASE-OUT

Most Plausible Alternative Technologies

125. With the exception of a few special applications, developed technology exists today to accomplish a complete phase-out of ODSs over a period of 3-4 years. However, some of the alternatives are not yet available in commercial quantities, and continued use of ODSs, especially in the service sector, is recommended in order to limit net incremental costs as will be demonstrated in Chapter 3.2.

126. Based on the most recent information from the UNEP Technical Options Report[1] and conferences held in Europe in February and March/April 1992 on ODS substitutes[2], Table 3.1 provides an overview of the most plausible technologies to replace ODSs in the different ODS using sectors of the Ghanaian economy. These substitutes are assumed to be commercially available and start replacing current ODS consumption in Ghana over a three year period up to 1995. Estimated net incremental costs of each substitute is shown in the last column of Table 3.1. The most plausible alternative technologies deemed appropriate for Ghana are summarized below.

Servicing of Domestic Refrigerators

127. Today, the preferred alternative refrigerant for manufacturing of new domestic refrigerators is HFC-134a, and most of the major international refrigerator manufacturers are expected to switch completely to this refrigerant during 1993-95. HFC-134a has an ODP of zero but can not be regarded as a drop-in substitute for domestic appliances, since new compressors and lubricating oil are necessary in connection with the transition.

128. Since the average consumption of CFC-12 related to servicing events for domestic appliances is in the range of 1 kg per unit as compared to an average charge of 0.5 kg or less, it is estimated, that increased awareness and modified servicing procedures can reduce the current consumption of CFC-12 for servicing of domestic refrigerators in Ghana by around 80%. The technical options are:

- To improve service procedures and increase the use of nitrogen or HCFC-22 for purging and leak testing. This option should achieve a 70% reduction in current

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[1]UNEP: Reports of the Technical Options Committees on Refrigeration, Air Conditioning and Heat Pumps; Flexible and Rigid Foams; Aerosol Products, Sterilants, Miscellaneous Uses and Carbons Tetrachloride; and Solvents, Coatings and Adhesives, December 1991

[2]International Conference, Berlin 24-26 February 1992: Alternatives to CFCs and Halons - Technologies and Substitutes; and International Polyurethane Industry Exhibition and Conference, the Hague 31 March - 2 April, 1992

Table 3.1. Assumed Substitutes for CFCs in Ghana

User sector	Current use	Substitutes assumed	Assumed earliest start date in Ghana	Assumed reduction potential	Unit substitution cost (USD/kg)
Servicing of domestic refrigerators	CFC-12	Better servicing procedures Recycling	1993 1993	75 5	1 5
Servicing of commercial refrigerators	CFC-12	Better servicing procedures Recycling	1993 1993	75 5	1.5 5
Industrial refrigeration	CFC-12 CFC-115 (in R-502)	Better maintenance and service procedures Recycling HCFC-22 Ammonia HFC-134a	1993 1993 1993 1993 1995	20 40 90 10 90	2 2 2 0 5
Mobile air conditioning	CFC-12	Better maintenance and service procedures Recycling HFC-134a	1993 1993 1995	75 12 100	1 5 10
Industrial chillers	CFC-11/12	Improved facilities HCFC-123/HFC-134a HCFC-22/ammonia	1993 1995 1993	20 100 100	4 9 2
Flexible foam	CFC-11	Methylene chloride, CO2/water	1993	100	0
Solvents	CTC	Unknown	2000	100	? [1]
Fire extinguishants	Halon-1211	Water, CO_2, powder/foam or other alternative	1993	100	? [1]

[1] Unit substitution cost has not been estimated, since the consumption is very limited and the actual applications are not identified. For this reason the incremental costs of phasing-out ODSs as solvents and fire extinguishants have not been estimated. The error thereby introduced is very small.

servicing use and should be economically viable in itself due to savings in refrigerant achieved.

- To introduce recovery and recycling of CFC-12 during service. In principle this option can eliminate an extra 10% of current CFC consumption in the domestic servicing sector. However, a significant part of domestic appliances are serviced by a huge number of small workshops which will not be able to afford recycling equipment. On the other hand an estimated 10-20 large workshops are likely to be able to invest in recycling equipment by themselves. It is therefore anticipated that only these large workshops will carry out recovery and recycling. The effect of this option is estimated to 5% of the current CFC consumption.

Commercial Refrigeration

129. Since the refrigerant and technology used in display cabinets for commercial purposes is the same as for domestic appliances the technical options available and the resulting effect are assumed to be similar to what is stated for domestic refrigeration.

Industrial Refrigeration

130. Better maintenance and service procedures are assumed to achieve a reduction in present ODS use of 20% in the industrial refrigeration sector. The techniques include elimination of recharging of leaky systems without proper repair, routine check-ups by qualified technicians, improved leak detection systems use of nitrogen/HCFC-22 or other methods for purging and leak testing. The reduction which maybe achieved will vary considerably between different plants depending on current practices.

131. Recovery and recycling during service is assumed to achieve a reduction of an estimated 40% related mainly to servicing of cold stores, refrigerated containers and trucks and plants installed on fishing vessels.

132. Existing CFC-12 systems may be retrofitted with HFC-134a. HFC-134a has properties very close to CFC-12, and retrofitting may be carried out by just replacing the compressor oil and refrigerant filter. While HFC-134a in some cases may grant an energy efficiency superior to the efficiency of CFC-12, it may, however, for other plants be necessary to optimize the system by replacing the evaporator or other components in order to achieve an efficiency rate similar to the rate of CFC-12. If HFC-134a may not be available in adequate amounts to satisfy the needs of developing countries, adaption of CFC-12 systems to HCFC-22 may be the ultimate solution at least in the medium-term perspective.

133. Existing R-502 plants may be converted to HCFC-22, since many R-502 compressors are designed to work with HCFC-22 as well. However, in some cases change from one to two stage compression may be needed.

134. New systems may be based on HCFC-22, HFC-134a or, for large systems, ammonia. HCFC-22 and ammonia systems are available in Ghana today. Since the growth in cold store and industrial refrigeration capacity in Ghana is expected to focus on smaller units (up till 50 Mt), it is assumed that 90% of the new refrigeration systems will be using HCFC-22 or HFC-134a, while ammonia will cover the remaining 10%.

135. Generally, ammonia installations have higher capital costs than HCFC-22 or CFC-12 systems but operating costs are lower, mainly due to smaller use of the cheaper ammonia refrigerant. HCFC-22 system are more expensive than CFC-12 systems, because of the higher price on HCFC-22. This is also the case for HFC-134a, for which not only the refrigerant but also new compressors and lubricating oil are more expensive. Experiences with retrofitting of existing CFC-12 systems with HFC-134a vary considerably - each case will have to be evaluated separately to determine the extent of modification needed.

Car Air Conditioning

136. Similar to domestic appliances HFC-134a is expected to replace CFC-12 in new car air conditioners. The costs and efficiency of HFC-134a to retrofit existing systems are still being studied and only preliminary estimates are available. Using HFC-134a as a retrofit may besides replacement of lubricant oil also demand replacement of other components and materials not compatible with HFC-134a. Since the typical lifetime for a car air conditioning system under Ghanaian condition is around 10 years, while the car in itself may last for 20-25 years, the actual choice of many car owners will probably be to scrap the existing system and use the car without air conditioning.

137. However, in the medium-term perspective substantial savings in CFC-12 consumption could be achieved by improving maintenance and servicing practices and introduce recovery and recycling of refrigerant by service.

138. The reductions achieved are assessed as follows:

- Improved maintenance and servicing practices covering inter alia changing of the current practice of using CFC-12 for purging and leak-testing may reduce the consumption by an estimated 75%, and

- Recovery and recycling of system charge instead of venting may add an extra 12% of reduction.

Large Industrial Chillers

139. Large industrial chillers designed for CFC-11 may be converted to use HCFC-123 or HCFC-141b. Internationally the focus seems to be on HCFC-123. Conversion to HCFC-123 of existing chillers may demand replacement of certain components or materials compatible with HCFC-123. Furthermore, leak detection systems and other precaution arrangements aimed at protecting workers health and safety will have to be installed since HCFC-22, HFC-134a, HCFC-

123 or ammonia may be installed. Large industrial chillers designed for CFC-12 may be retrofitted with HFC-134a.

140. It is known that a few plants do not have proper facilities for emptying and storing of refrigerant during servicing while several plants are without automatic systems for early warning of leakages. Taking into account the large quantities of CFC often contained in industrial chillers, investments in such facilities may be profitable in many cases, besides that substantial amounts of CFC's may be saved.

Flexible Foam for Mattresses and Cushions

141. As noted earlier the CFC-substitute preferred by Ghanaian manufacturers is methylene chloride. Although aware of the occupational health problems related to methylene chloride the manufacturers deem it essential to be able to produce low-density foam qualities (down to around 16 kg/m^3) in order to withstand competition from illegally imported foam products manufactured in neighbouring countries, which include parties as well as non-parties to the Montreal Protocol. The manufacturers do not believe in that the consumers will accept similarly priced higher density products as a replacement for low-density products.

142. With suitable adaptation and production control, slab stock with foam densities down to 18-19 kg/m^3 could be safely produced by CO_2/water blowing with the existing facilities in Ghana. The production employs standard foam formulations with new polyols which are available from several suppliers. However, foam densities below 18 kg/m^3 cannot (at least for the time being) be produced without special blowing agents like CFC's and methylene chloride. Since methylene chloride is toxic and possibly carcinogenic to humans, it should not normally be recommended as a suitable control option.

143. Considering the special conditions for flexible foam manufacturing in Ghana and the global need to phase-out consumption of CFC's, methylene chloride may, however, be accepted as a transitional substitute for CFC-11. A precondition for this recommendation is that the Factory Inspectorate, which is the authority responsible for occupational health and safety, is strengthened in order to ensure that production facilities are equipped with adequate safety measures to avoid occupational accidents related to the use of methylene chloride.

Fire Extinguishers

144. For portable/transportable halon-1211 fire extinguishers a number of alternatives are available including water, CO_2, and foam/powder solutions. The alternative to be preferred will have to be evaluated on a case by case basis. The cost associated with replacement of halon equipment can only be estimated with great uncertainty, since the implications of the fire accident including secondary damages will influence the picture heavily. Measures to ensure recovery and recycling during service of existing equipment could be introduced, but the current consumption is very small and the main effect of such measures would be to preserve the bank of halons present in Ghana and hereby to expand the lifetime of the existing halon base fire fighting equipment.

CTC Uses

145. The consumption of CTC in Ghana is very small and the exact uses have not been investigated. For these reasons the issue of alternatives will not be addressed.

Analyses of Phase-out Scenarios

Methodology

Model: CFCCOST

146. A computer-based linear programming model (CFCCOST) has been developed with the purpose of identifying the phase-out schedule with the lowest net incremental cost subject to the requirements set by the Montreal Protocol for developing countries. The model also enables the user to analyze the costs and benefits (in terms of ODS use eliminated over the period 1992-2010) of alternative phase-out scenarios e.g. tightening of the reduction requirements in the Protocol.

147. For each phase-out scenario, the model selects the substitution techniques and timing of ODS reduction actions that will minimize total costs. If for instance a technology is readily available and can be implemented at zero or low incremental costs, this option will be given priority in implementation compared to a more expensive alternative within one of the other end-user sectors.

148. The operation of the model requires a set of input data including:

- specification of ODS use by application areas;
- present and projected future demand for ODSs within each end-user sector;
- present number and age profile of domestic refrigerators (according to refrigerators purchased new or second-hand);
- incremental unit substitution costs for the control options (substitutions techniques) application in each end-user sector;
- rate of servicing of domestic refrigerators;
- maximum reduction potentials, i.e. the amount of CFC that can be eliminated within an application by implementing a given control option;
- start date and market penetration time for each control option (the market penetration time is defined as the time that is expected to pass from the date where the control is commercially available in Ghana to the date where it has reached its maximum reduction potential), and

- specification of maximum consumption levels allowed under different phase-out scenarios.

149. The model operations result in the calculation of the following output:

- the present value of total incremental cost of ODS substitution over the period 1992-2010. The cost is expressed in 1992 US $;

- the total accumulated ODS use (1992-2010) with and without ODS regulation;

- the optimum choice of control options, i.e. the most cost-effective timing and choice of available substitution technologies;

- the cost-effective total substitution costs for the individual application (user costs), and

- the costs to the consumers of premature scrapping of refrigerators.

Incremental Costs

150. The incremental costs may be incurred in three sectors in Ghana:

- ODS user industries;
- at the level of final consumers, and
- in the Government sector.

151. The methodology used is to identify costs where they first arise thus ignoring the fact that most of the additional costs in the manufacturing sector will eventually be passed on to consumers of the product in the form of higher prices.

User Costs

152. The incremental costs incurred in the Ghanaian ODS user sector include the following elements:

- capital costs of new production facilities or conversion of existing facilities and of new equipment such as recovery and recycling machines;

- operational costs including raw materials, labour, energy, waste disposal, etc.;

- costs of retraining of personnel, including research and development to adapt technology to local circumstances, and

- cost of technical assistance and engineering support.

Consumer Costs

153. Costs incurred directly by the final consumers results from:

- forced early replacement of refrigerators, which cannot be recharged because of non-availability of ODSs (it is assumed that CFC-12 is available for servicing up to the year 2010 but none is available hereafter), and

- extra cost of buying CFC free refrigerators instead of CFC-12 refrigerators.

154. The situation in Ghana is complicated because a substantial share of the refrigerator import consists of second-hand refrigerators. These used refrigerators are much cheaper compared to new refrigerators but they have higher energy consumption. The price of used refrigerators is modified to take this difference in energy consumption into account. Below a discussion of the issue of new versus second-hand refrigerators is presented. This issue is very important in relation to the situation in Ghana.

Governments Costs

155. The Government itself will incur economic costs in complying with the Montreal Protocol, e.g. for strengthening institutions to implement the necessary laws and regulations, monitor ODS use, carry out information dissemination, etc.

156. Finally, it should be noted that all incremental costs are calculated on the basis of existing economic and industrial policies in Ghana. Thus, the model does not include the potential economic savings of prohibiting small-scale, inefficient production as a consequence of the national ODS regulation.

Discount Rate

157. A real discount rate of 10% is used in all model calculations to annualize capital costs over the lifetime of the investment and discount future cash flows to comparable present values. This is consistent with the discount rate used in other Country Programmes for ODS phase-out in developing countries.

Domestic Refrigerators

158. It is estimated that 75% of the annual import of domestic refrigerators are second-hand refrigerators and only 25% are new. As the price of second-hand refrigerators is lower than the price of a new refrigerator, restrictions on the availability of CFC based refrigerators will increase the cost to the consumers more than in a situation where new CFC based refrigerators are replaced by new HFC-134a refrigerators. The cost of phasing-out CFC in domestic refrigeration can thus be expected to be much higher in Ghana compared to countries without import of second-hand refrigerators.

159. This issue is included in the CFCCOCST model by operating with both second-hand and new CFC based refrigerators. It is thus possible to choose a cost-effective phase-out pattern which consists of a different time profile for the two refrigerator stocks.

Estimating the Price of Second-hand Refrigerators

160. As the concept of cost in principle includes all social cost elements it is not correct just to use the private buying price of a second-hand refrigerator as the social cost of such a refrigerator. Comparing second-hand and new refrigerator revealed that they differ in two respects. The average lifetime of the new refrigerators is estimated at 20 years compared to 10 years for the used one. This requires that the consumer purchases two second-hand refrigerators instead of a new one. Secondly, the energy consumption of the old refrigerators is substantially above the consumption of a new refrigerator. In Table 2 below the cost of the two kinds of refrigerators are summarized under different assumptions with respect to the price/cost of electricity.

161. The determining factor for the cost of second-hand refrigerators is the price of electricity. The production cost has been estimated at approximately US $0.10 per kWh, while the average consumer price is only US $0.02. Using the electricity price of US $0.10 per Kwh means that the social cost of second-hand refrigerators exceeds the social cost of new refrigerators suggesting that switching to the import of only new refrigerators would be economically viable.

162. However, this will have a significant distributional effect on the Ghanaian consumer and it is, therefore unlikely that electricity prices will be increased to reflect the real costs of electricity production. Therefore, the actual consumer price of electricity has been used in the following phase-out scenarios. This implies that the cost of second-hand refrigerators is estimated at approximately US $300 compared to the price of US $500 for a new one. It is estimated that the extra cost of the CFC free refrigerator is US $10 compared to a new CFC-based. The difference for a second-hand refrigerator is thus US $210. The incremental cost of substituting the import of used refrigerators with new is, thus, significant.

Consumer Cost and Welfare Loss in the Case of Second-hand Refrigerators

163. When the consumer faces a situation where the availability of CFC is restricted there are the following options:

- buying cheap second-hand refrigerators as long as possible and then scrapping the refrigerator when it needs service; in this situation the loss to the consumer is the cost of premature scrapping;

- buy a CFC free refrigerator (second-hands are estimated to be available after 10 years, i.e. after 2006); here the welfare loss is the extra price for the CFC free refrigerator, and

Table 3.2 Cost of second-hand refrigerators in Ghana.

	Energy price/cost			
Cost/price in 1992 USD	0.02 US$ per kWH		0.10 US$ per kWh	
	New	Second-hand	New	Second-hand
Energy consumption in kWh/day	0.6	3.0	0.6	3.0
Price of refrigerator	500	100	500	100
Discounted energy cost	41	205	205	1025
Discounted refrigerator price	500	142	500	142
Real price of refrigerators incorporating differences in energy consumption	500	306	500	963

- give up the purchase of a refrigerator or postponing the purchase leading to a welfare loss for the consumer.

164. The government has the opportunity of restricting or banning the purchase of second-hand refrigerators if it is estimated, that the cost of unforseen premature scrapping exceeds the welfare loss associated with the restriction or the ban.

165. In the calculation of incremental cost of a ODS phase-out no explicit behavioral analysis has been made. It is assumed that the demand for refrigerators must be fulfilled and the cost of restricting the availability of second-hand refrigerators is the extra cost of purchasing a new CFC free refrigerator until second-hand CFC free refrigerators become available. Such an estimate of social cost might be an overvaluation.

Description of Different Phase-out Scenarios

166. Two alternative phase-out scenarios have been analysed:

(a) The allowable phase-out, i.e. a scenario that postpones ODS phase-out until the latest possible date while keeping the country within the limits of the Montreal Protocol.

(b) Accelerated phase-out strategy (minimum cost phase-out), i.e. phase-out at a pace set by the availability of technology and minimization of costs.

167. Scenario 1 is characterized by full utilization of the 10 year delay provision in the Protocol whereas scenario 2 can be characterized as an early phase-out implying low total ODS use and low total incremental costs. The scenario 2 phase-out strategy is considered to be a good approximation for the minimum cost phase-out.

168. The reduction requirements in each of the two scenarios (in percent of the base year demand) is shown in table 3.3 below. Since consumption levels of ODSs differ from those included in Appendix A, Group 1 of the Montreal Protocol (halons, methyl chloroform, and carbon tetrachloride) are very low, these other substances were not included in the scenario analysis.

169. According to the Protocol, the base which ODS reduction requirements are measured against is defined as the average consumption in 1995, 1996 and 1997 or 0.3 kg per capita if this were lower. In Ghana, the projected unconstrained demand for ODSs in the years 1995-1997 is approximately 0.01 kg per capita which is much below the 0.3 kg limit, so the first mentioned base definition applies. For the recommended phase-out scenario 2, 1991 has been chosen as base year.

Comparison of Alternative Phase-out Scenarios

170. The two scenarios are compared with respect to:

Table 3.3. Reduction Requirements in Alternative ODS Phaseout Scenarios

Scenario	1. Allowable phaseout requirements	2. Accelerated phaseout requirements
Base year	Average of unregulated ODS consumption in 1995, 1996 and 1997	1991
Reduction schedule as % of base year demand	Freeze by 1999 50% by 2005 85% by 2007 100% by 2010	Freeze by 1993 50% by 1995 75% by 1998 85% by 2007 100% by 2010

- total incremental cost and total reduction achieved;
- ODS consumption profile over the period, and
- development in stocks of domestic refrigerators.

The Total Incremental Cost and Total Reduction

171. In Table 3.4, the results of scenarios are compared with respect to total incremental phase-out costs and the associated environmental benefits in terms of ODS use avoided over the period 1992 to 2010. It should be emphasized here, that the costs in Table 3.3 are only indicative figures given all the uncertainties inherent in their calculations. Nevertheless, the order of magnitude is regarded as realistic in view of the experiences gained in other countries.

172. The total incremental costs are substantially higher in the allowable scenario compared to the accelerated phase-out scenario. This difference is caused by high cost of premature scrapping of CFC based refrigerators. It can be divided on the cost of scrapping of refrigerators bought new, US $4.6 million, and refrigerators bought second-hand, US $3.3 million.

173. In addition to creating lower incremental cost, the benefit of the accelerated phase-out schedule is a reduction of 86% of the total unconstrained demand for ODS in Ghana from 1992 to 2010 compared to 73% for the allowable phase-out schedule. As a result of this the cost per kilogramme ODS removed is only US $0.3 in the accelerated phase-out while it is US $1.4 in the allowable phase-out scenario.

ODS Consumption Profile Over the Period

174. Figure 3.1 compares the ODS consumption profile over the period 1992-2010 in the two different phase-out scenarios. The Montreal Protocol requirements are also shown as well as the unrestricted consumption.

175. Before year 2000 the annual consumption increases in the allowable phase-out scenario but less than that of the unrestricted situation. This reduction is caused by measures which imply no incremental cost such as replacing CFC-11 in flexible foam production with methylene chloride. Furthermore, the allowable phase-out scenario shows that the Montreal Protocol becomes binding for Ghana in year 2005. The accelerated phase-out implies consumption well below the Montreal Protocol during the whole period. The main reason for this deviation is a faster introduction of better service and maintenance procedures. These are relatively cheap measures which can be initiated soon.

Development in Stocks of Domestic Refrigerators

176. In Figure 3.2 and Figure 3.3 the development in the stock of second-hand and new CFC based refrigerators and CFC free refrigerators are illustrated for the two scenarios.

Table 3.4. Costs and Benefits of Alternative Phaseout Scenarios

Scenario	ODS use eliminated over the period 1992-2010 ODP tonnes (% of total unconstrained demand [1])	Incremental user costs Mill. USD (1992 present value)	Incremental consumer costs Mill. USD (1992 present value)	Total incremental costs Mill. USD (1992 present value)	Discounted cost per kg ODS eliminated USD/kg	Marginal cost USD/kg
1. Allowable phase-out	6200 (73%)	0.5	8.4	8.7	1.4	-6.5
2. Accelerated phaseout	7300 (86%)	1.2	1.3	2.5	0.3	

[1] Total unconstrained ODS demand over the period 1992 - 2010 is estimated at 8500 ODP tonnes.

Figure 3.1. ODS Consumption under the Different Phaseout Schedules (1992-2010)

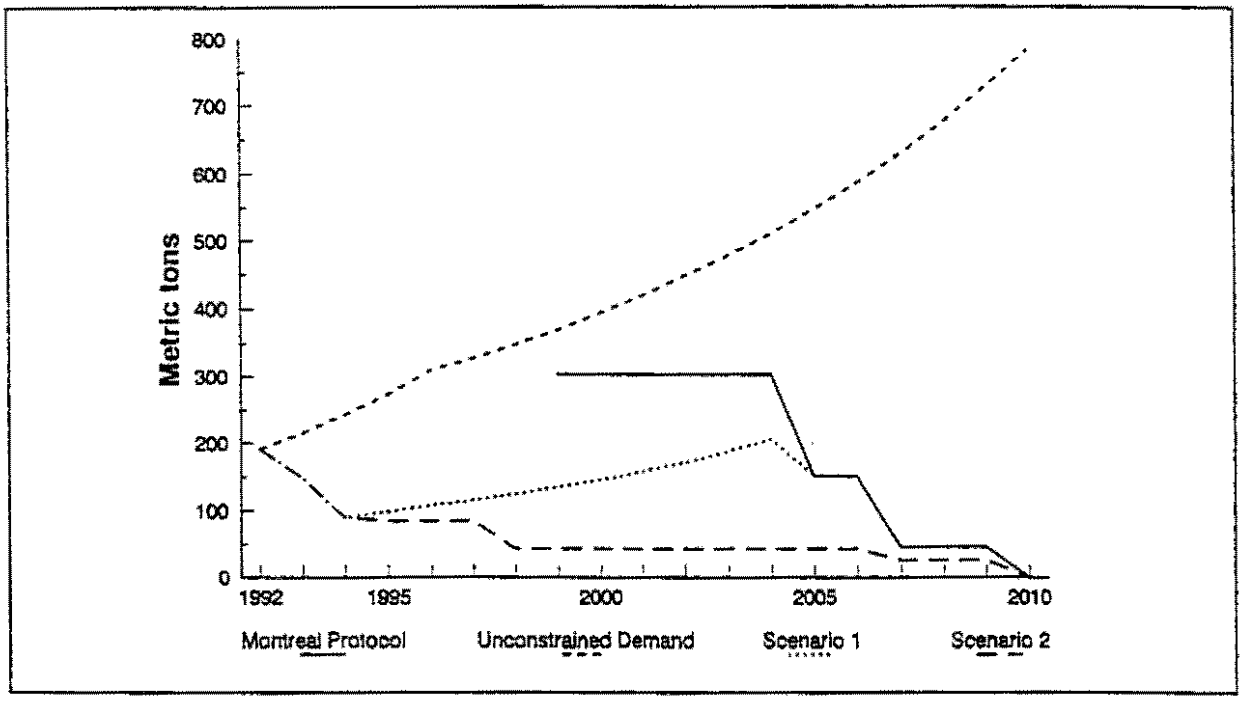


Figure 3.2. Development in refrigerator stock in the allowable phaseout scenario.

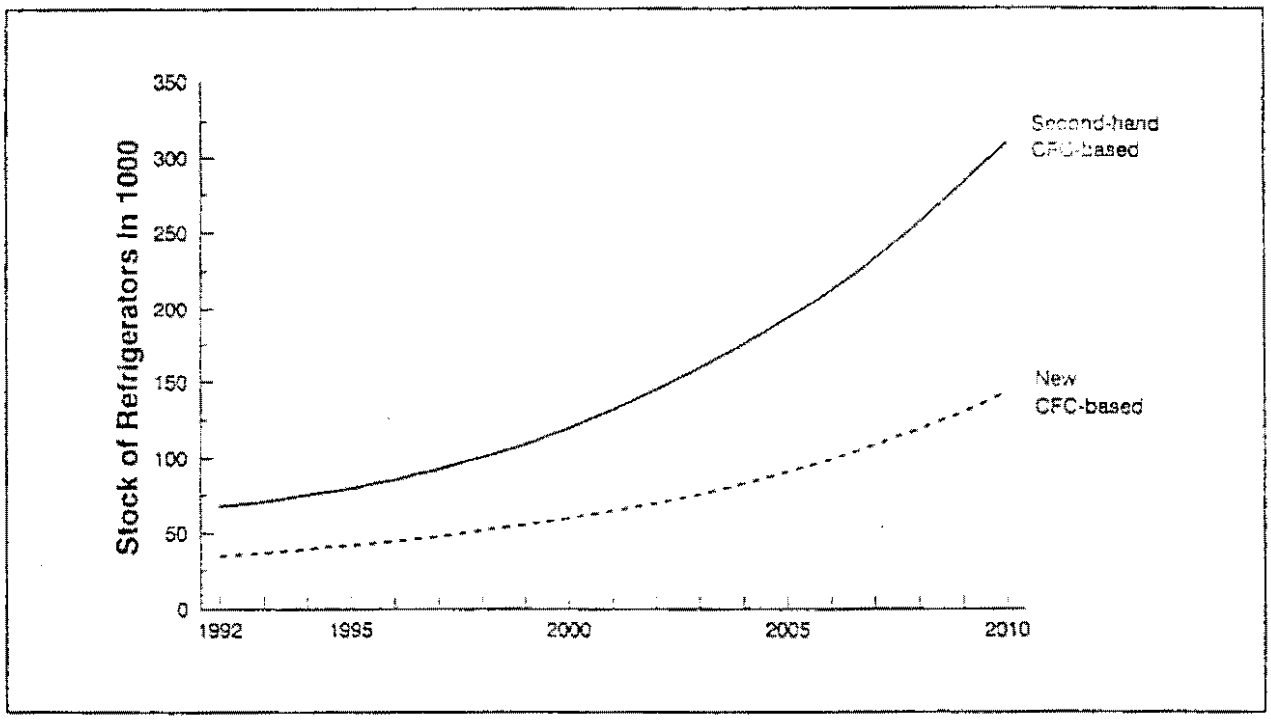
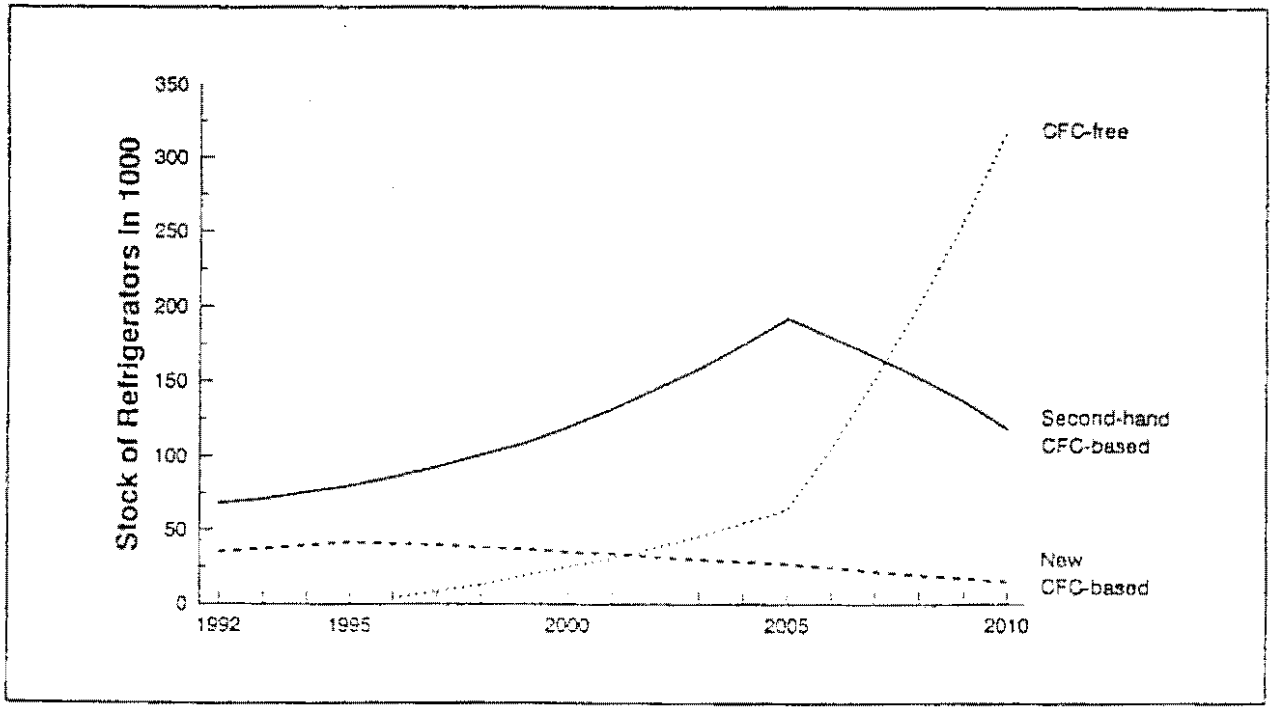


Figure 3.3. Development in refrigerator stock in the accelerated phaseout scenario.



177. In the allowable scenario the stock of refrigerators will increase as incorporated in the growth assumption (see Table 2.4 for further details). The stock of second-hand refrigerators is assumed to be 3 times the number of new. The cost of premature scrapping of used CFC-12 refrigerators will only be half of the cost of scrapping the new despite the fact that there are three times as many. This is because it is assumed that the second-hand CFC-12 refrigerators will be replaced by second-hand HFC-134a refrigerators and because the lifetime of the second-hand refrigerators is only half a new refrigerator.

178. In the accelerated phase-out scenario the development in the composition of the different kinds of refrigerators is unlike the allowable scenario. The import of CFC-12 refrigerators will shift towards the HFC-134a type as soon as this model is commercial available in 1996. Therefore the stock of new CFC-12 refrigerators will decrease from 1996 and onward. In 2010 the stock consists of refrigerators with only a short remaining lifetime and thus the cost of premature scrapping will be moderate. The second-hand CFC-12 refrigerators will not be substituted by CFC free refrigerators before these can be bought as second-hand.

The Recommended Phase-out Schedule

179. A phase-out schedule that is more demanding than the Montreal Protocol is interesting for two reasons. Firstly, it is likely that ODS producers in Europe and the USA will shut down their ODS production capacity in line with the bans on ODSs in their home markets. Although the Protocol allows for some continued production to meet the needs of Article 5 countries, it is not yet clear that this will be a commercially viable option for the producers. In any case, there is a risk that CFC prices will rise, making an accelerated phase-out even more attractive. It should be emphasized that both scenario 1 and 2 assume that ODSs will continue to be available on the Ghanaian market up to year 2010 in amounts that are sufficient to meet demand by all sectors.

180. Secondly, there is a growing concern about the extent of depletion of the ozone layer which may lead to further tightening of the Protocol at coming meetings of the parties - next in November 1992 where the EC is certain to call for a global tightening in line with the already decided closing date of January 1st, 1996 in all EC member countries.

Effect of Non-availability of CFCs after 2000

181. The case of non-availability of CFCs after 2000 is particularly problematic in connection with domestic refrigeration. For the other applications it will at least to some extent be possible to retrofit the equipment. Therefore, the cost of premature scrapping of industrial refrigeration equipment is assumed to be limited. For domestic refrigeration the situation is different. If CFCs are no longer available for Ghana to import after year 2000 and no drop in substitutes become commercially available, total incremental costs will increase dramatically.

182. As an example of the consequences of non-availability of CFC-12 after 2000, it has been estimated that the total incremental cost of the recommended phase-out will rise to 12 million US $ compared to the US $2.5 million under the assumptions included in the recommended or accelerated phase-out. One of the options proposed by the National Committee to avoid this

phenomenal increase in the incremental cost is to provide a CFC Bank for the domestic refrigeration sector for the period 1995-2010 at an estimated cost of US $480,000.

183. In the scenarios analyzed above it is assumed that all commercial and industrial refrigeration systems are replaced gradually over the period 1996-2010 as they become obsolete. The results stresses the importance to developing countries (as well as other countries with high service rates) of having access to CFCs or drop in substitutes for servicing of their refrigeration equipment for a period of 10-15 years after production of ODS free refrigeration equipment is commenced.

184. The significant increase in incremental costs of non-availability of new CFCs makes widespread recycling of CFCs more attractive from an economic point of view. As long as new CFCs can be bought at current prices recycling is only cost effective in the case of larger workshop repairs.

Recommended Phase-out Strategy

Government Objectives

185. The recommended phase-out schedule is based on the accelerated phase-out scenario (Scenario 2 above). This phase-out schedule reflects the Governments strategic objectives of:

- minimizing Ghana's consumption of ODSs;
- minimizing the cost to Ghanaian industries and consumers of following the Montreal Protocol;
- reliance on existing legal framework;
- reliance on general economic and industrial policies;
- continuing fulfilment of the demand for vital products currently made with or using ODS without compromising the objectives of the Montreal Protocol, and
- introducing regulations that are socially acceptable and economically feasible.

186. The total incremental costs of this phase-out schedule is estimated at US $2.5 million (net present value). This is subject to review when the full impact of regulatory measures are assessed. The benefit is a reduction in total unconstrained ODS consumption of 86% over the period 1992-2010, corresponding to 7,300 ODP tonnes.

187. The recommended phase-out schedule is ahead of Protocol limits as can be seen in Figure 3.1. In 1998, a reduction level is achieved which corresponds to the 85% requirement comprised in the Montreal Protocol. From 1998 to 2006 the consumption level is constant. In the beginning the reduction in consumption for refrigeration is achieved by improving servicing and

maintenance procedures. Thereafter, the phase-out is more slowly, because of the long lifetime of most refrigeration equipment. Here, the reduction is mainly caused by replacement of CFC based equipment with new CFC free equipment at the speed of which the existing equipment becomes obsolete.

Recommended Phase-out Schedule

188. The planned consumption of ODSs until complete phase-out is shown in Table 3.5 by substance and in Figure 3.4 by end user sector.

4. ACTION PLAN

Government Actions

189. The following are the recommended institutional actions to be taken by the Ghanaian Government in order to ensure an effective implementation of the Action Plan to phase-out the use of ODSs in the country. They comprise five key elements:

(a) Institutional framework for implementation of the Action Plan.

(b) Monitoring system for ODS use.

(c) Introduction of regulatory measures.

(e) Introduction of a certification arrangement for refrigeration technicians.

(f) Introduction of an inspection scheme for imported refrigerators.

(g) Information dissemination.

190. A summary of the recommended government actions is provided in Table 3.6 and each of the five key elements are discussed in further detail below.

Institutional Framework for Implementation of the Action Plan

191. As described earlier a National Committee for ODS and an Ozone Office under EPC has already been created. This institutional framework is deemed appropriate for implementation of the Action Plan. The total resource requirements for this action covering the period of 1992-1995 has been estimated at US $166,000. The description of this requirement is provided in project IS-1 of Annex A.

Monitoring System for ODS Use

192. A monitoring system for ODS use by substance was introduced in Ghana from the beginning of 1992. The system is based on the fact that all importers of controlled substances have to obtain permission for import from the Ozone Office, before import can be initiated. The Customs, Excise and Preventive Service will supply copies of all import declarations concerning ODSs to the Ozone Office, enabling the Office to be in control of all legal import of ODSs classified according to substance and importer. To the extent more detailed information regarding consumption among end users is needed, the Ozone Office will approach the importers for details and monitor stocks as well as use.

193. It should be noted, that Ghana faces a problem of illegal import of ODSs, the extent of which varies depending on the prices of ODSs in Ghana as compared to the neighbouring

countries. EPC has estimated the size of the illegal import. This figure is included in the consumption data stated in this report.

194. The resource requirements for monitoring this action are included in the cost estimate for the National Committee and the Ozone Office stated above.

Regulatory Measures

195. The following regulatory measures are recommended as important and essential elements in the effective implementation of the national ODS phase-out strategy:

a) Bans on the use of ODSs for specific purposes at specifically given dates in accordance with the recommended ODS phase-out strategy. A draft schedule of proposed bans is provided in Table 3.7. It should be noted, that this schedule is by no means definite but serves as a guideline. Further studies into the detailed consumption patterns and negotiations with the ODS using industry is mandatory before issuing any bans. A legal and economic consultant will assist in these activities.

   A special issue to be considered is the need for a ban on second hand equipment containing or designed for controlled substances. The objective of such a ban is to ensure that Ghanaian citizens are not wasting their savings on buying equipment which cannot be serviced due to shortage in supplies of CFC's. Whether and when such shortages will occur over the period from year 2000 to 2010 is difficult to say, but the problem should not be overlooked. Second hand equipment using new refrigerants as HFC-134a will likely be available to Ghanaian citizens from around the year 2006. If a ban on second hand equipment using CFC-12 is introduced before this time a number of Ghanaian citizens, who cannot afford to buy new equipment, will in reality suffer from a reduced standard of living until second hand equipment based on new refrigerants is available. On the other hand, the ban on such imports could be influenced by their availability from the exporting countries, i.e. by the policies adopted by Governments and the Parties with respect to export of CFC-containing refrigerators from non-Article 5 countries.

b) Special ODS tax on imports of all controlled substances. The purpose of the tax is to encourage the initial substitution of ODSs in easily substitutable applications such as flexible foam manufacturing. Furthermore, the revenue from the ODS tax could be used for partly financing of the costs related to the activities of the National Committee for ODS and the Ozone Office besides financing minor projects aimed at ODS substitution and information dissemination. The tax should be higher than the incremental substitution costs in these applications but small enough to avoid motivating illegal import. A tax US $0.5-1 per kg is suggested. Tax increases will be considered at a later stage in the phase-out plan.

c) Tax exemptions for imports of ODS conserving technology. Imports of ODS conserving technology such as recovery and recycling machines should be exempted from the general import duty.

196. The EPC will be the lead agency in implementing and monitoring the various regulatory measures. However, since EPC has no legislative and enforcement power, EPC will act by giving recommendations to other Ministries and government bodies, primarily: the Ministry of Finance and Economic Planning; the Ministry of Trade and Tourism; the Ministry of Industries, Science and Technology and the Factory Inspectorate. The ODS taxes and tax exemptions will be collected and managed by the Customs, Excise and Preventive Service.

197. The resource requirements needed for EPC's activities in this respect are covered by the cost estimate for institutional strengthening. For the activities of other government bodies it is assumed, that there will be no need for extra resources, except in certain cases, technical assistance to strengthen their capability to carry out the new responsibilities.

Introduction of a Certification Arrangement for Refrigeration Technicians

198. It is recommended that a certification arrangement is introduced for technicians, who successfully have completed the training programme to be initiated for refrigeration technicians (refer to Project Proposal R-1). It is, furthermore, recommended that this certification arrangement is linked to the existing system for approval of company operations administered by the Ministry for Industries, Science and Technology such that all workshops/companies operating or undertaking service on refrigeration equipment as a precondition for approval must document that their staff includes certified technicians.

199. The details of this arrangements have yet to be worked out (see Project Proposal R-1). However, it is anticipated that a transition period (e.g. three years), within which a public awareness programme will be carried out, will be allowed in order to ensure that all existing refrigeration technicians have been trained and made conversant with the new system before it is fully implemented.

200. The cost of implementing this arrangement is covered by Project Proposal R-1 for the period 1993-1995.

Information Dissemination

201. Although some of the major importers and users of ODSs in Ghana appear well informed of the Montreal Protocol and of efforts to develop substitute chemicals and technologies, the majority of users as well as the typical Ghanaian are not aware of the ozone depletion problem. Information campaigns which address small enterprises as well as industrial users and consumers should, therefore, be launched.

202. The use of seminars, television media, pamphlets, posters, newspaper articles, etc. is envisaged together with distribution of international and national findings on ODS alternatives to the implied enterprises and industries. Efforts in this respect by consumer and business/industrial associations will be supported as well.

203. The cost of this activity is included in the costs of institutional strengthening.

Project Proposals

204. Three projects are proposed for funding from the Multilateral Fund - one project for each of the sectors: refrigeration, flexible foam manufacturing and institutional strengthening. A brief description of each project is provided below and in Table 3. The timing of activities is shown in Table 3.8. A detailed description of the project proposals is provided in Annex A.

205. The total incremental costs of the proposed projects have been estimated at US $672,000 in 1992 prices over the period from 1992 to end of 1995. In addition, the cost of US $480,000 has been estimated for CFC-12 refrigerant security stock for the period 1993 - 2010.

206. The Government of Ghana would like at a later stage to forward proposals for projects related to retrofitting of industrial refrigeration equipment by new HFC- or HCFC-refrigerants. The development of proposals for such projects has been deferred pending availability of sufficient supplies of the new refrigerants and maturity of new technologies. However, technical assistance will be sought to develop the required project proposals in the most propitious time.

Table 3.7: Summary of Proposed Projects

Sector	Project Description	Project Elements	Duration	Project Cost US $ (1992 Prices)
Cross-Sector	IS-1: Institutional Strengthening - Establishment of monitoring and co-ordination mechanism for implementing programme to phase-out ODS	National Ozone Office National Committee on ODS Monitoring and Information Dissemination Public Awareness Programme Regulatory Measures	1992-1995	160,000
Refrig-eration	R.1: Improved Servicing and Maintenance within the Refrigeration Sector	R-1.1: Establishment of National Committee for Improved Refrigeration Practices (NCIRP) R-1.2: Training of Refrigeration Technicians in Improved Servicing and Maintenance Procedures R-1.3: Technical Assistance for the Reduction of ODS Consumption in the Refrigeration Sector R-1.4: Refrigerant Security Stock	1993-1995	427,000 480,000
Foam	F-1: Elimination of the use of ODS in the Foam Sector	F-1.1: Technical Assistance to Flexible Foam Producing Companies F-1.2: Technical Assistance for Expertise F-1.2: Health and Safety Audits	1993-1994	85,000

Project R-1: Improved Servicing and Maintenance within the Refrigeration Sector

207. The purpose of the project is to create a lasting improvement of the maintenance and servicing procedures currently being employed in Ghana. The project will cover procedures related to all kinds of refrigeration equipment in use, including domestic refrigerators, air-conditioning systems, industrial ODS-refrigeration and ammonia refrigeration.

208. The objective will be achieved by training of refrigeration technicians, establishing of

codes of good practices, strengthening of an existing training facility for demonstration proposes, introduction of certification arrangements for refrigeration regulating and technicians and strengthening the expertise of the Ministry of Industries, Science and Technology and the Factory Inspectorate Department as the government bodies responsible for monitoring maintenance standards etc.

Project F-1: Reduction of the use of CFC-11 in the Foam Sector - Technical Assistance to Assist in Technology Transfer for the Elimination of CFC-11 in the Flexible Foam Manufacturing Sector

209. The purpose of the project is to provide the necessary information, expertise and guidance to the enterprises concerned to enable them to gain the confidence for changing over to non-ODS technologies in the flexible foam manufacturing sector. It is also to provide expertise to the Ministry of Industries, Science and Technology and the Factories Inspectorate Department to be able to monitor the implementation of the project and regulate its health and environmental impacts, especially in the substitution of CFC-11 with methylene chloride as an auxiliary blowing agent. At the moment, neither the Ministry of Industries, Science and Technology nor the Factories Inspectorate Department has the means or the expertise to assist or monitor the foam sector activities.

210. The technical assistance is necessary if the Government's objective of phasing-out the use of ODS in the foam sector as early as possible is to be achieved and sustained.

211. The objective will be achieved through a consultancy for the enterprises concerned, a study tour of selected industry and government representatives in a country, preferably an Article 5 country where relevant expertise is available and provision of equipment to the Factories Inspectorate Department to enable it to conduct a health and safety audit and monitor the effect of methylene chloride as a substitute for CFC-11.

Table 3.8: Schedule for Project Implementation

Projects	1992	1993				1994				1995			
	4	1	2	3	4	1	2	3	4	1	2	3	4
IS-1: Acquisition of Office Equipment	X												
Organization of Public Awareness Campaign		X	X	X	X	X	X	X	X	X	X	X	X
Study and Drafting of Regulations		X	X	X	X	X	X	X	X	X	X	X	X
R-1:													

Establishment of NICRP		X											
Training-Study and Planning		X											
Selection of Participants		X											
Acquisition of Equipment - Establishment of NRDC (refrigeration demonstration centre			X										
Training of Trainers			X										
Acquisition of Equipment				X									
Training of Technicians				X	X	X	X	X	X				
Evaluation of Training Programme									X				
TA for Nitrogen Production			X										
TA for Inspection System			X										
Implementation of Improved Servicing Programme				X	X	X	X	X	X	X	X	X	X
Development of Certification System			X	X	X								
Implementation of Certification System										X			
Acquisition of CFC-12 Security Stock						X							
F-1:													
Public Education - Awareness		X	X	X	X								
Formulation of Sector Regulations				X	X				X	X	X	X	X

Implementation of Sector Regulations													
TA for Industries			X										
Industry - Government Agencies Training		X											
Acquisition of Equipment by FID		X	X										
Implementation of Phase-out													
Health and Safety Audit and Monitoring				X	X	X	X	X	X	X	X	X	X

Time Schedule for Implementation of the Action Plan

212. Table 3.9 shows the suggested phasing and duration of the proposed projects. The projects will be initiated as soon as the Government has succeeded securing the funds necessary for implementation.

Budget and Financing of Activities 1992-1995

213. Table 3.10 gives a breakdown of project costs by components and by year of implementation for the period 1992-1995. It is proposed that all incremental project costs not covered by other funding are funded by the Interim Multilateral Fund. The costs of the Government Action Plan are proposed covered by the Fund as a project for institutional support. Once the incremental costs of the proposed projects are approved by the Multilateral Fund, appropriate funds handling mechanisms will be set up.

214. Total incremental costs are estimated at US $1,152,000.

This is made up of:

Proposed projects: US $672,000
Refrigerant stock: US $480,000

215. Table 3.9 indicates the summary of the cost of the Government Action Plan within.

Table 3.9: Summary of the Cost of Country Programme Activities for the Period 1992-1995

	1992	1993	1994	1995	Total
Institutional Strengthening including: - Regulatory Measures - Public Awareness	10,000	51,000	49,500	49,500	160,000
Improved Servicing and Maintenance within the Refrigeration Sector	12,000	301,000	62,000	52,000	427,000*
Elimination of the use of ODS in the Foam Sector	29,000	50,000	3,000	3,000	85,000
Sub-total	51,000	357,000	115,000	104,500	672,000
Refrigerant Security Stock		480,000			480,000
TOTAL	51,000	882,000	115,000	104,500	1,152,000

* The actual amount being requested for this sector is US $328,000, which takes into account US $99,000 within the UNDP Work Programme for 1991.

ANNEX A

PROJECT PROPOSALS

PROJECT COVER SHEET

Country:	**Ghana**
Project Title:	**Institutional strengthening for the phase-out of ozone-depleting substances**
Sector Covered:	**Cross-sectoral**
ODP Consumption in Sector affected:	**Not applicable**
Project Duration:	**3 years**
Project Impact:	**Enhancement**
Total Budget:	**US $160,000**
Implementing Agency:	**UNDP**
Coordinating National Agency:	**Environmental Protection Council**

PROJECT SUMMARY

1. Since no institutional mechanism exists in the country for organizing Ghana's response to the amended Montreal Protocol an Ozone Office was established in 1991 within the Environmental Protection Council (EPC) to provide the needed co-ordinating mechanism. In addition, a technical interministerial/interdepartmental committee has also been established to formulate strategies, prepare and periodically evaluate action programmes for phasing-out the ODSs.

2. In view of the competing demands on the government's limited resources and budgetary constraints support from the Interim Multilateral Fund will be needed to ensure the effective functioning of the Ozone Office and the National Committee on Ozone Depleting Substances (NACODS).

Project Description

3. The Environmental Protection Council (EPC) is the government body responsible for liaising with national and international bodies on environmental matters. The establishment of the National Committee on ODS and the Ozone Office will provide a dedicated institutional infrastructure for carrying out these roles and ensuring informed and effective implementation of actions to phase-out the ODS in Ghana.

4. The functions of NACODS will include the formulation of action programmes for the phase-out of the ODSs, review progress of their implementation and advise the government through the EPC.

5. The functions of the Ozone Office include the following:

- to act as Secretariat for the National Committee on ODS;
- to co-ordinate and facilitate activities related to the phase-out of the ODS;
- to monitor activities related to ODS use in Ghana and advise on Ghana's compliance with the Montreal Protocol;
- to collect, collate, analyze and disseminate information on the ozone problem and related issues;
- to facilitate exchange of information with other Parties and organs established by the Protocol;
- to facilitate access of local entrepreneurs to relevant information, particularly the OzonAction computerised information system, to relevant experts, specialists and technology transfer, and
- to participate in relevant meetings on ozone issues.

6. The Ozone Office will be run by one full-time professional officer and one middle-level full-time supporting staff with computing skills. Two local consultants (a legal officer and an economist) will be engaged from time to time to assist in drafting the legal documents identified in the Country Programme and to make the necessary economic analysis. The office will have access to expertise and other facilities available within the EPC, such as Public Relations Unit, and other technical divisions. One professional officer could assist the office, if necessary, on a part-time basis.

Purpose of the Project

7. The main purpose of the project is to enhance the capability of the EPC to co-ordinate the implementation of government actions developed to comply with the provisions of the Montreal Protocol.

Elements of the Project

8. The project comprises:

- establishment of a National Committee on Ozone Depleting Substances (NACODS);
- establishment of a National Ozone Office and acquisition of requisite equipment for the office, and
- organization of public awareness campaigns.

Project Organization and Management

9. The professional officer in charge of the office will act as the Co-ordinator of the Country Programme activities and report to the Executive Chairman of the EPC, who is the Chairman of NACODS. He will also act as Secretary to NACODS and ensure that quarterly reports on the progress of implementation are prepared and distributed to members of NACODS and relevant agencies. The organization of the activities of the office and reporting procedures will follow procedures laid down for managing UNDP-sponsored projects in the country.

Project Costs

10. All project costs will be incremental cost to be provided from the Interim Multilateral Fund. The cost elements are as follows:

	1992 US $
One-Time Set-Up Costs	
Equipment:	10,000
- Personal computer and accessories	
. monitor	
. disk drive	
. printer	
. modem	

. software
. voltage stabilizer (UPS)

- Air conditioner
- Photocopier
- Fax machine

Staff Requirement	1993 US $	1994 US $	1995 US $	Total for 3 years
One Professional Staff	12,000	12,000	12,000	36,000
One Supporting Staff	7,200	7,200	7,200	21,600
Legal Consultant (Five man-months)	5,000	5,000	15,000	15,000
Economic Consultant (One man-month	2,000	2,000	2,000	6,000
Operational Costs (Including clearing-house functions, organization, of NACODS, task groups, public awareness programmes, etc.	20,000	20,000	20,000	60,000
Total	55,200	45,200	45,200	145,600
10% Contingency	5,520	4,520	4,520	14,560
Total Estimate	60,720	49,720	49,720	160,160

Budget

11. The estimated budget of the project is, therefore, US $160,000. The distribution is as follows:

Year	US $
1993	61,000
1994	49,500
1995	49,500
Total	160,000

Benefits of the Project

12. Although the project does not lead to direct elimination of ODS it will provide the means for achieving an expeditious phase-out process in Ghana.

PROJECT COVER SHEET

Country:	**Ghana**	
Project Title:	**Improved Servicing and Maintenance within the Refrigeration Sector (Project R-1)**	
Sector Covered:	**Refrigeration**	
ODP Consumption in Sector affected:	**73 metric tons per year (1991-figure)**	
Project Duration:	**3 years**	
Project Impact:	**Reduced ODS consumption: Approx. 50 metric tons per tons per year (1991-figure) Add impact on consumption of HCFC-22 as well**	
Proposed Budget:	**Total Budget:**	**US $907,000 (Including US $480,000 representing the cost of CFC-12 security stock at 1993 prices)**
Implementing Agency:	**UNDP**	
Coordinating National Agency:	**Environmental Protection Council**	

PROJECT SUMMARY

1. The purpose of the project is to create a lasting improvement of the maintenance and servicing procedures currently being employed for refrigeration equipment in Ghana, thereby significantly reducing the consumption of ODSs within the refrigeration sector. The project will cover procedures related to all kinds of refrigeration equipment in use, including domestic refrigerators, air-conditioning systems, industrial ODS refrigeration and ammonia refrigeration. For ODS refrigeration plants the project will focus on minimizing CFC emissions caused by venting, purging leak testing and recharging of refrigeration systems by introducing improved servicing practices regarding recharging, recovery/recycling, the use of nitrogen or other compounds for purging and leak testing etc. For ammonia plants the project will focus on improving occupational health and safety practices, through improved maintenance and operational procedures, thereby aiming at promoting the use of ammonia as an environmentally safe substitute for ODS refrigerants.

2. The objective will be achieved through training technicians, establishing of codes of good

practices for servicing and maintenance etc. of refrigeration equipment, introduction of certification arrangements for refrigeration technicians and strengthening of the Factory Inspectorate as the government body responsible for monitoring these activities.

Project R-1: Improved Servicing and Maintenance within the Refrigeration Sector

Project Description

Background

3. The refrigeration sector is the dominant user of CFC's in Ghana. The sector comprises:

- Domestic and commercial refrigerators and freezers.
- Cold stores including small stores (container size) as well as medium and large sized.
- Refrigeration plants onboard fishing vessels, refrigerated trucks and containers.
- Car air conditioning.
- Room air conditioning as well as central building air conditioning plants.
- Large factory chillers.

4. The CFC's employed covers CFC-11, CFC-12, CFC-115 (in R-502) and HCFC-22. Besides this many large cold stores and industrial refrigeration plants onboard fishing vessels are using ammonia.

5. With respect to manufacturing, installation, servicing and maintenance of refrigeration equipment in Ghana the following characteristics should be noted:

- All domestic and commercial appliances together with car and room air conditioning units are imported and no manufacturing of such equipment takes place in Ghana, although a limited number of car air conditioning systems are installed in Ghana. A dominant part of the import is second hand units. Service and maintenance of this kind of equipment are primarily carried out by a large number of refrigeration workshops, of which around 95% is organized in NARWOA (the National Air Conditioning and Refrigeration Workshop Owners Association).
- Larger refrigeration plants including cold stores, refrigeration plants onboard fishing vessels, central building air conditioning plants and central factory chillers are installed in Ghana based on imported equipment and materials. Installation, servicing and maintenance maybe carried out by technicians from the company who owns the plant (this is in particular the case for very large plants) or by a number of refrigeration companies/workshops specialized within these fields. Some of these

companies/workshops are organized in NARWOA.

- Although a number of refrigeration companies/workshops are focused on either domestic appliances and similar small units or large refrigeration plants, a number of companies/workshops will do both. It is difficult to make a clear distinction between technicians working with domestic appliances and the like and technicians working with larger plants.

- Installation, servicing and maintenance of ammonia plants are done primarily by technicians employed by the company which owns the plant or by specialists from abroad. However, at least one independent servicing company has been established in the latest years. There is a clear distinction between technicians dealing with ammonia and technicians dealing with CFC's.

6. The number of technicians employed for installation, maintenance and servicing of CFC-based refrigeration appliances and equipment is roughly estimated at around 5000. It should be noted, at present no official certification requirements exist for refrigeration technicians, and anybody would in principle be allowed to carry out servicing activities for refrigeration equipment.

7. The consumption of CFC's in 1991 for the different applications and the reduction potential by simple means as improved maintenance and servicing procedures has been estimated as indicated in Table 1.

8. For domestic and commercial appliances as well as air conditioning units the estimated reduction potential equals, that the consumption of CFC-12 for each service event is often more than four times the actual charge of the unit. This high consumption is due to the use of CFC-12 for purging and leak testing as well as the fact that many technicians and apprentices "in order to do a proper job" are using considerably more CFC than actually needed, when recharging the refrigeration circuit. Some of the larger workshops servicing these types of equipment are well aware of the option to use nitrogen for purging operations and also prefer to use HCFC-22 for leak testing due to it's higher pressure. However, frequent shortages of nitrogen as well as of CFC-12 and HCFC-22 force the workshops to use whatever substance is available. The logistics behind these shortages are not known, but should be identified.

9. For cold stores and industrial refrigeration plants the wastes of refrigerant due to purging and leak testing is significantly less than for domestic appliances and similar small units. However, a certain scope for substitution of CFC-12 by nitrogen etc. for purging and leak testing operations exist, besides that CFC-12 based plants, which typically are smaller plants with a CFC-content of less than 15 kg per plant, will seldom be equipped with facilities for storage of refrigerant during servicing events.

10. The large factory chillers are normally well operated and equipped with facilities for storage of CFC during service. However, a few plants are without such facilities, besides that the plants are often old and thereby prone to leakages. Improved maintenance and introduction

of automatic systems for early warning of leakages may minimize the frequency and consequences of such events.

11. The potential for recycling stated in Table 1 is estimated based on the assumption that recycling will be relevant for the part of the consumption that will not be affected by improved maintenance and servicing procedures. It is furthermore assumed, that recycling will be practised by simple recovery and cleaning before the refrigerant is recycled back into the same appliances. Recycling based on this principle may be carried out by relatively simple equipment already available on the market at a modest price. Still it must be recognized that only the largest refrigeration workshops will be able to afford such equipment, despite the fact that the equipment can be used for recycling of HCFC-22 as well as CFC-12 and R-502.

12. Table 1: Consumption and reduction potential for CFC's within the refrigeration sector by simple means.

13. The project described here aims at achieving the reduction potentials indicated in table 1 by:

- training of technicians undertaking maintenance and service of refrigeration equipment;
- establishing codes of good practices for installation, maintenance and servicing of refrigeration plants;
- providing a technical facility for continuous training and strengthening existing training institutions;
- establishing certification arrangements for refrigeration technicians;
- strengthening the Factory Inspectorate to undertake a monitoring function regarding maintenance standards and other relevant issues at industrial refrigeration plants etc., and
- studying ways of removing the constraints on the supply of nitrogen for servicing refrigeration equipment.

14. This consolidated effort towards improved practices within the refrigeration sector will be focused on CFC-plants as well as HCFC- and ammonia plants. The focus on ammonia plants is based on the fact, that lack of tradition for preventive maintenance, that is widespread in many developing countries including Ghana often combines the use of ammonia with unnecessary safety risks. Actually, a trend away from ammonia towards HCFC-22 can currently be observed in Ghana. Taking into account the environmental benefits of ammonia as being the only well-tested refrigerant without any ozone depleting and global warming potential, it is deemed important in the project to include an effort aimed at reverting the current trend and hopefully not only maintain but also increase ammonia's share of the market. An essential effort in this

regard will be the strengthening of the Factory Inspectorate, since the Inspectorate is the government body responsible for monitoring and ensuring occupational health and safety conditions at industrial plants in Ghana.

15. Other important features of the project are the creation of a National Committee for Improved Refrigeration Practices (NCIRP), the development of national codes of good practices, establishment of certification arrangements and the linking in with existing training institutions. These elements are important to ensure, that the project will have a lasting impact on refrigeration practices in Ghana.

16. It should be noted that under the UNDP project GHA/91/G66 funds have already been allocated for teaching of correct servicing procedures related primarily to domestic refrigeration and air conditioning units. The total amount allocated for 1991 and 1992 totals US $99,000. However, since this project has not yet been planned in detail, it is assumed that these funds can be utilized as part of the funding required for the project described in this proposal.

Purpose of the Project

17. The purpose of the project is to create a lasting improvement of the maintenance and servicing procedures currently being employed for refrigeration equipment in Ghana, thereby significantly reducing the consumption of ODSs within the refrigeration sector. The project will cover procedures related to all kinds of refrigeration equipment in use, including domestic refrigerators, air-conditioning systems, industrial ODS refrigeration and ammonia refrigeration. For ODS refrigeration plants the project will focus on minimizing CFC emissions caused by venting, purging, leak testing and recharging of refrigeration systems by introducing improved servicing practices regarding recharging, recovery/recycling, the use of nitrogen or other compounds for purging, leak testing etc. For ammonia plants the project will focus on improving occupational health and safety by improved operations and maintenance etc, thereby aiming at promoting the use of ammonia as an environmentally safe substitute for ODS refrigerants.

Project Elements

18. The project comprises the following elements:

- establishment of a National Committee for Improved Refrigeration Practices (NCIRP). The Committee will be a working committee responsible for organization and implementation of the project. The Committee should include representatives (experienced technicians) from the existing relevant training institutions, NARWOA, industrial users of refrigeration equipment, companies installing industrial refrigeration equipment together with representatives from the Ministry of Industries, Science and Technology, the Factory Inspectorate Department and EPC. The Committee may find it appropriate to subdivide itself into working groups specializing on different kind of equipment (domestic appliances versus industrial plants, etc.) The Committee act as the Refrigeration Committee of NACODS and report to it.

19. The main functions of NCIRP will be:

- to establish criteria for selection of participants of training sessions;
- to develop proposals for certain codes of practice for consideration by NACODS and the Government;
- to develop procedures for certification of refrigeration mechanics, and
- to plan and review programme activities of the National Refrigeration Demonstration Centre.

(1) training of a number of Ghanaian instructors, who should include teachers of refrigeration technology in the existing training institutions as well as experienced workshop technicians;

(2) training of a number of refrigeration technicians from selected workshops and industry, and

(3) set up in one of the training institutions a national demonstration laboratory for continuous training and retraining of refrigeration mechanics.

20. Technical assistance from institutions which have already developed programmes on proper maintenance and servicing practices. The advisor(s) shall support NCIRP in organizing and implementing the project besides organizing instruction abroad.

21. Investment in equipment and necessary training materials, including a number of CFC recovery and recycling machines to be placed at the training institutions and a few larger service shops and used for demonstration during the training programmes.

PROJECT COMPONENTS

22. The project will be carried out under the following sub-projects.

Sub-project R-1.1: Establishment of a National Committee for Improved Refrigeration (NCIRP):

23. The National Committee for Improved Refrigeration Practices will be formally established as soon as the Country Programme is approved as a necessary condition for successful implementation of the projects within the refrigeration sector. Its establishment, supported by government regulation would provide a much needed institutional framework in an area where there doesn't seem to be any supervisory organization.

24. The tasks to be accomplished will include:

- develop a criteria for selection of technicians to be trained and assist the Ozone Office in organizing the training programme;
- develop a code of practice for all the sectors of the refrigeration industry;
- develop certification procedures;
- study the establishment of an inspection and certification system for all imported used refrigerators;
- study the means of providing a reliable source of nitrogen for servicing and maintenance of refrigerators;
- establish a National Refrigeration Demonstration Centre and monitor its activities;
- study the status of industrial refrigeration and the need for systems retrofit, and
- develop criteria for the establishment of and access to a CFC-Bank, if necessary.

25. The technician attached to the NRDC will act as Secretary to the Committee. The Committee will carry out some of the main tasks through technical assistance by consultancy service. The NCIRP, through its Secretary, will report to the NACOD quarterly.

Sub-project R-1.2: Training of Refrigeration Technicians in Improved Servicing and Maintenance Procedures.

Phase I: Training of Trainers

26. Following acquisition of the requisite equipment a foreign consultant will be engaged to conduct a two week training workshop for 30 trainers in two sessions. The participants will be drawn from all the sectors of the refrigeration industry. They will be people with formal educations in allied refrigeration techniques and will be capable of training other technicians. The participants will include one each from the Ministry of Industries, Science and Technology and the Factories Inspectorate Department and the relevant technical institutions. Five recovery/recycling machines will be acquired for this phase of the training programme.

Phase 2:

27. Following the training and acquisition of more equipment, three day training sessions will be organized by the trainers in four major cities in the country to train about 500 more technicians from all the major workshops in the country. Each training group will have about 25 trainees. Ten more training machines will be acquired for this phase of the training programme.

Phase 3: Acquisition of Charge Recovery/Recycling Machines

28. By the completion of the second phase of the training programme 40 units of recovery/recycling machines would have been acquired for use by the major refrigeration service workshops. The NCIRP will work out criteria for their distribution.

Phase 4: Continuous Training

29. The National Refrigeration Demonstration Centre will continue the training programme and provide three day training sessions to technicians who have not been trained.

Phase 5: Evaluation and Follow-up

30. Progress reports will be prepared by the NCIRP after each session of training. These reports will evaluate project progress and achievement and provide recommendations for any strategic adjustments in the programme.

Sub-project R-1.3: Technical Assistance for the Reduction of ODS Consumption in the Refrigeration Sector

31. Technical assistance will be required for the NCIRP:

(a) To identify factors that create shortages in the supply of nitrogen and recommend measures that would ensure reliable supply. The success of the training programme in reducing consumption of CFC-12 presupposes the availability of adequate quantities of nitrogen for purging and other related service activities. Analyses of the growth in refrigerators indicate that the quantity of nitrogen needed will amount to an average of about 560 metric tons by the year 2010. The average demand between 1993 - 2010 is 33 metric tons per year. It is essential that a means be found to guarantee the supply of the required nitrogen.

(b) To establish a domestic refrigerator inspection and certification programme. In order to avoid excessive demand on available stocks of CFC it is necessary that imported used refrigerators that land at the port do not create an immediate demand for CFC. Thus, an inspection scheme which makes it possible to identify and scrap unserviceable or uncharged used CFC refrigerators is intended to be put in place.

(c) To study systems that need retrofit. It is considered that by 1995 retrofitting would be an essential practice in Ghana. A study of the situation will be necessary to ascertain the extent, costs and other needs. Three technicians will be sponsored for a two week study tour abroad to understudy retrofitting practices and assist local enterprises as part of the on-going training scheme.

Project R-1.4: Refrigerant Security Stock (Refrigerant Bank)

32. It is anticipated that by 1995 most major producers of CFCs in Europe (main source of

CFCs to Ghana) would have stopped production of CFC-12. The reduction in supply and concomitant rise in prices would force a very high level of incremental cost attributed to premature retirement of domestic refrigerators. At US $50 per refrigerator this is estimated at about US $23 million over the period 1995 - 2010, or an average of US $1.53 million per year.

33. In order to ensure continued service of the refrigerators needing servicing it is planned to purchase and store a security stock for use when supplies become short and prices rise. Table T.1 indicates CFC-12 and nitrogen requirements for servicing (columns four and five respectively). From the analysis, 107 metric tons of CFC-12 will be required between the period 1993 - 2010 to service domestic refrigerators.

34. It is assumed that requirement for larger CFC-12 equipment could be met through recycling.

PROJECT EVALUATION

35. The project will be initiated immediately following Executive Committee approval with funds already available within UNDP's Work Programme amounting to US $99,000.

36. The following are the planned phases:

- Establishment of NCIRP (Action initiated)	3 months
- Training of trainers of refrigeration technicians	6 months
- Evaluation	1 year
- Establishment of a National Refrigeration Demonstration Centre	3 months
- Technical assistance programme (staggered)	3 years
- Implementation of improved servicing procedures	3 years

Project Organization and Management

37. The Environment Protection Council will have the overall responsibility for co-ordinating the project and will initiate discussion with the Ministry of Industries, Science and Technology with the view to formally establishing the National Committee on Improved Refrigeration Practices as an umbrella organization for regulating the refrigeration service industry.

Table T.1

REFRIGERANT REQUIREMENTS FOR DOMESTIC REFRIGERATORS

Assumptions:	
Number of households	3,100,000
Household with refrigerator	2.00%
Domestic refrigerator anual growth rate (1991–2006)	10.00%
Scrapp rate of refrigerators per year (2006–2014)	10.00%
Importation of CFC–based refrigerator ceases from	1 January 2006
Average charge of CFC per refrigerator	0.20
Nitrogen used per refrigerator serviced	1.00
Per cent of refrigerators serviced per year	20.00%

Year	Units with CFC–12	CFC–12 (Mton)		N2 for service (Mt)
		In units	For service	
1991	62,000	12.4	2.5	12.4
1992	68,200	13.6	2.7	13.6
1993	75,020	15.0	3.0	15.0
1994	82,522	16.5	3.3	16.5
1995	90,774	18.2	3.6	18.2
1996	99,852	20.0	4.0	20.0
1997	109,837	22.0	4.4	22.0
1998	120,820	24.2	4.8	24.2
1999	132,903	26.6	5.3	26.6
2000	146,193	29.2	5.8	29.2
2001	160,812	32.2	6.4	32.2
2002	176,893	35.4	7.1	35.4
2003	194,583	38.9	7.8	38.9
2004	214,041	42.8	8.6	42.8
2005	235,445	47.1	9.4	47.1
2006	211,900	42.4	8.5	42.4
2007	188,356	37.7	7.5	37.7
2008	164,811	33.0	6.6	33.0
2009	141,267	28.3	5.7	28.3
2010	117,722	23.5	4.7	23.5
TOTAL		558.8	111.8	558.8
CFC–based refrigerators in operation after 2010:				
2011	94,178	18.8	3.8	18.8
2012	70,633	14.1	2.8	14.1
2013	47,089	9.4	1.9	9.4
2014	23,544	4.7	0.9	4.7

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38. An external consultant will be engaged to identify specific needs for the training programmes. An initial (8) number of recycling/maintenance equipment will be ordered for establishing a training demonstration centre in one of the technical institutes in Accrue where refrigeration courses are undertaken.

39. A full time technician will be engaged on secondment to the institute concerned to assist in running the centre.

40. The institute will be requested to appoint one staff member who will be the co-ordinator on a part time basis.

41. The Centre will be available for the normal instruction of the institute and be used for short-term training of technicians in the field in a way that would cause minimum disruption to the normal academic schedules of the institute. The NCIRP will act as the Board to the Centre. a contract spelling out responsibilities and obligations may be entered into between the EPC and the institution concerned.

42. Training of trainers will begin as soon as the equipment is made available.

43. The second phase of the training will start when the additional 32 pieces of equipment are made available.

44. The use of equipment for improved servicing will start following completion of training in the second phase and distribution of servicing schedules.

45. Technical assistance for improving on the supplies of nitrogen will be linked with the first phase of the training project to ensure that nitrogen will be available in order to achieve the objectives of the project.

Project Costs

46. All project costs are considered as incremental costs. The project costs are as follows:

		1992 US $	1993 US $	1994 US $	1995 US $
I.	Sub-project R-1.1				
	Operational Costs:				
	Local Consultant	800	3,500	3,500	3,500
	Certification Programme/ Code of Practice	10,000	10,000	10,000	10,000
	Sub-Total	10,800	16,500	13,500	13,500

Sub-total (3 years): US $54,300

II. Sub-project R-1.2

Phase 1:			
Initial Study and Planning:			
External Consultant (24 days)	23,000		
Local Consultants	1,000		
8 Recycling Equipment	28,000		
Demonstration Shop Preparation	5,000		
Local travel, training materials, documentation	5,000		
Organization Costs - DSA for Participants, etc.	4,000		
Sub-total	66,000		
Phase 2/3:			
32 Recycling Machines	112,000		
Organizational Costs:			
Honorarium for Trainers, DSA for Participants, etc.	25,000		
Documentation, Training Materials, etc.	8,000		
Sub-total	145,000		
Phase 4:			
Establishment of NRDC:			
Equipment (to be provided from Phase 1)			
Sample Equipment - Refrigerator, etc.	3,000		
Technician	8,400		8,400
Part time Co-ordinator	6,000	6,000	6,000
Operational Costs	5,000	5,000	5,000
Short-term Training Costs	5,000	10,000	5,000
Sub-total:	27,400	20,400	22,400

Sub-total (3 years): US $70,200

(Sub-total for R-1.2: US $281,200)

III. Sub-project R-1.3 (a and b)

External Consultant (20 days)	17,000		
Local Consultant	1,000		
Local Travel and Expenses	2,000		
Sub-total	20,000		
Sub-project R-1.3 (c)			
15 Day Study Tour by 3 refrigeration technicians (Air Fare, DSA, Training Fee)		23,000	
External Consultant (10 days)			10,500
Local Travel and Miscellaneous Expenses			2,000
Sub-total	20,000	23,000	12,500

Sub-total (3 years): US $55,500

SUMMARY OF PROJECT COSTS

Item	1992	1993	1994	1995	Total
Sub-project R-1.1	10,800	16,500	13,500	13,500	54,300
Sub-project R-1.2		238,400	20,400	22,400	281,200
Sub-project R-1.3		20,000	23,000	12,500	55,500
Sub-total	**10,800**	**274,900**	**56,900**		
10% Contingency	1,080	27,490	5,690	4,740	38,800
TOTAL	11,880	301,290	61,490	52,140	426,800
TOTAL REQUEST	**12,000**	**301,000**	**62,000**	**52,000**	**427,000**

Funds available with UNDP: US $99,000.
Funds needed for sector: US $328,000.

Sub-project R-1.4: Refrigerant Security Stock (CFC-12 Bank)

47. The costing is based on the forecast of 1993 prices submitted by the main supplier of CFC in Ghana. The prices are C and F only. The CFC will be supplied in disposable packages equipped with non-refillable valves. In addition to safety precautions, such valves prevent refilling and potential leakage during such refilling.

Quantity Required	:	110 metric tons
Cost of 1 Metric Ton CFC-12	:	US $3,780
Cost of 110 Metric Tons CFC-12	:	US $415,800
10% Contingency	:	US $41,580
5% Storage Charges	:	US $20,790
Total	:	US $478,170
Estimated Cost of CFC Bank	:	US $480,000

48. The cost represents refrigerant requirement for the period 1993 - 2010.

Benefits of the Project

49. When the project has been fully implemented a reduced consumption of around 50 tons of CFC's per year (based on 1991-consumption figures) should be expected. To this should be added the savings in the consumption of HCFC-22, which, however, has not been calculated. It is noted the full implementation of the project may take longer than the initial project period, since not all refrigeration technicians will have the opportunity to attend training courses during the initial project period. This fact should be taken into consideration when the achievements of the project is evaluated. The time needed for full implementation will depend on to what extent the certification arrangement introduced is linked to the existing system for approval of company operations (refer to main report, section 3.4.1 - Government actions) and the transition period decided.

50. The long time effect of the project will be considerably higher taking into account the increasing demand for refrigeration equipment in Ghana and the aim of promoting the use of ammonia as an environmentally safe substitute for HCFC-22 and CFC's in large industrial installations.

PROJECT COVER SHEET

Country:	**Ghana**
Project Title:	**Elimination of the use of ozone depleting substances in the foam sector - Technical assistance for the elimination of CFC-11 in the flexible foam manufacturing sector**
Sector covered:	**Flexible foam**
ODP Consumption in Sector affected:	**24 tons per year (1991-figure, constrained)**
Project Duration:	**3 years**
Project Impact:	**Reduced ODS consumption: 24 tons per year (1991-figure)**
Proposed Budget:	**Total Budget: US $85,000**
Implementing Agency:	**UNDP**
Coordinating National Agency:	**Environmental Protection Council**

PROJECT SUMMARY

1. The objective of the project is to provide technical assistance to the industrial sector as well as the relevant government agencies to ensure speedy and cost-effective phase-out of the use of CFC-11 in the sector, and to address health and environmental problems related to the use of substitutes, in particular methylene chloride.

2. The project objectives will be achieved through three sub-projects addressing the issues of technical assistance for the selection of appropriate technology for phase-out and for health and safety measures and training through study tours. These actions will be supported by a regulation prohibiting the use of controlled ozone depleting substances in flexible foam blowing by a specific date (1 January 1995) and relevant public education programmes well ahead of the effective date of the regulation.

Project F-1: Elimination of the use of Ozone Depleting Substances in the Foam Sector - Technical Assistance for Technology Transfer for the Elimination of CFC-11 in the Flexible Foam Manufacturing Sector

PROJECT DESCRIPTION

Background

3. There are nine flexible foam manufacturing factories with installed capacity of 5,540 metric tons per year with a capacity utilization of about 30% (1991). About 24 metric tons of CFC-11 was used in the sector in 1991. The substitute of choice for CFC-11 seems to be methylene chloride although other potential substitutes such as carbon dioxide/water formulation and HCFC-123b which are in use elsewhere are being considered.

4. Some of the foam manufacturers attempted to switch over to methylene chloride. However, due to lack of expertise, these manufacturers experienced product quality problems attributed to the new technology. This resulted in substantial financial losses compelling them to revert to CFC-11 technology. Thus, only one factory has been able to switch to the use of methylene chloride.

5. Secondly, in view of the inherent problems related to the use of methylene chloride new handling, storage, disposal and monitoring techniques for the substitute and the foam product under Ghanian conditions have been of concern to the industry and need to be considered to ensure confidence in the new technology and its health and safety effects on workers.

6. The Ministry of Industries, Science and Technology is responsible for formulation of government's industrial policies, promotion as well as regulation of industries, while the Factories Inspectorate Department is responsible for regulating occupational health and safety. Neither of these government agencies have the requisite expertise to assist the sector to switch over to the new technology in a sustained and environmentally sound manner.

Purpose of the Project

7. The purpose of the project is to provide technical assistance to the enterprises concerned to help them in the change-over and to the Ministry of Industries, Science and Technology and the Factories Inspectorate Department to enable them to provide the necessary backstopping for sustainable change-over.

PROJECT ELEMENTS

8. The project will consist of three sub-projects, namely:

Sub-Project F-1.1: Technical assistance to flexible foam producing companies;

Sub-project F-12: Technical assistance for provision of expertise through training for Ministry of Industries, Science and Technology and Factories Inspectorate Department, and

Sub-project F-13: Technical assistance for health and safety audits in the foam manufacturing industry.

Sub-project F-1.1: Technical Assistance to Flexible Foam Producing Companies

Initial Phase

9. Following further consultations between the Ozone Office and the Ministry of Industries, Science and Technology on the one hand and the foam manufacturers on the other, the services of a consultant will be requested. The consultant will study the sector situation and all the issues related to a change-over to ozone-benign technologies in the sector and recommend the most appropriate course of action and costs, if necessary. The consultant's recommendations will reflect on the implementation schedule of the project. See paragraph 18 below.

10. The consultant will also assist the Ozone Office in identifying possible institutions abroad for study tour by three representatives from the industry sector and one each from the Ministry and the Factories Inspectorate Department.

Follow-up Phase

11. Following the completion of training for the industry and government representatives the consultant will assist the sector in effecting the phase-out with the trained officer from the Ministry as his counterpart. After implementation the staff members from the Ministry and the Factories Inspectorate will monitor progress of implementation and submit periodic reports to the Ozone Office.

12. The consultancy service required is about 30 man-days.

Sub-project F-1.2: Technical Assistance for Provision of Expertise through Training for the Ministry of Industries, Science and Technology and the Factories Inspectorate Department

13. A schedule officer with a background in chemical engineering or chemistry will be selected from the Ministry of Industries, Science and Technology for four week practical training in the relevant foam manufacturing technology through a study tour or attachment at an appropriate factory or institution abroad.

14. A similar arrangement will be made for the Factories Inspectorate Department. However, in this case the tour will be divided into attachment at a factory and at an occupational health institution.

15. After the training the staff members will continue as regular members of staff of their institutions, but will have special responsibility for flexible foam manufacturing companies. They will also train other members of staff.

16. In collaboration with the Ozone Office they will organize seminars for the industry.

Project F-1.3: Technical Assistance for Health and Safety Audits in the Foam Manufacturing Industries

17. Following training of a staff member of the Factories Inspectorate Department, the Department will conduct health and safety audits in the flexible foam manufacturing enterprises where methylene chloride is used as a substitute. The results of the audits will help determine actions , whether engineering or educational, that need to be taken to maintain satisfactory safety standards. The Department will also set standards of exposure which it will monitor.

PROJECT EXECUTION

Time Schedule

18. The project should be initiated as soon as funds are approved for it by the Executive Committee of the Interim Multilateral Fund. The planned duration of the project phases is as follows:

. Enactment of sector regulation and public education	6 months
. Technical assistance to sector	0.5 year
. Training	0.3 year
. Implementation	
(a) Without incremental costs following technical assistance	1.0 year
(b) With incremental costs	1.5 years

Project Organization and Management

19. The Environmental Protection Council will have the overall responsibility for the project. The National Committee on ODS, with the assistance of a local legal consultant will prepare a draft sector regulation for consideration by industry and the Ministry of Industries, Science and Technology. The Ministry will have the direct responsibility for overseeing and

monitoring the phase-out and will report periodically to the National Committee on Ozone Depleting Substances through the Ozone Office.

Incremental Costs of the Project

20. As a technical assistance project all costs will be incremental costs. The project costs are as follow:

Project F-1.1

Technical assistance: Consultant for 30 days:	US $
Fee (US $500 x 30)	15,000
Daily subsistence allowance(US $125 x 35)	4,400
Return air fare (two trips)	6,000
Local travel	600
	26,000
10% Contingency	2,600
Total	28,600 (29,000)

Project F-1.2

Study tour/attachment for five officials for four weeks:

Fee (US $3,000 x 5)	15,000
Daily subsistence allowance (US $120 x 5 x 30)	18,000
Organizational costs (host institutions)	5,000
10% Contingency	3,800
Total	41,800 (42,000)

Project F-1.3

Equipment and additional operational costs to Factories Inspectorate Department (FID) for safety audits and monitoring and additional operational costs to the Ministry of Industries, Science and Technology (MIST):

Monitoring and analytical equipment	5,500
Operational costs (FID) (1993-1995)	4,500
Operational costs (MIST) (1993-1995)	4,500
Total	14,000

Summary of Project Costs

	US $
1) F-1.1	29,000
2) F-1.2	42,000
3) F-1.3	14,000
Total	85,000

Budget

Year	US $
1992	29,000
1993	50,000
1994	3,500
1995	3,000
Total	85,000

Benefits of the Project

21. The project will result in the phase-out of the consumption of CFC-11 in the flexible foam sector amounting to 24 metric tons/year or about 25% of the country's consumption (1991) in two and one-half years.