PROJECT COVER SHEET

COUNTRY:	REGIONAL / East Europe and Central Asia
IMPLEMENTING AGENCY:	UNIDO
PROJECT TITLE:	Demonstration Project on the Replacement of CFC Centrifugal Chillers in Croatia, Serbia and Montenegro, Romania and Macedonia
PROJECT IN CURRENT BUSINESS PLAN:	No
SECTOR:	Refrigeration
SUB-SECTOR:	Air Conditioning and Process Cooling
PROJECT IMPACT (ODS TO BE ELIMINATED):	28 ODP-weighted mt
PROJECT DURATION:	36 months
PROJECT COSTS:	
Incremental Capital Cost:	US$ 3,500,000
Co-financing:	(US$ 1,280,000)
Contingency (10% of equipment cost):	US$ 222,000
Total Project Cost:	US$ 2,442,000
Requested Grant:	US$ 2,442,000
Implementing Agency Support Cost:	US$ 183,150
Total Cost Of Project To Multilateral Fund:	US$ 2,625,150
Status Of Counterpart Funding:	Commitment confirmed by counterpart
Project Monitoring Milestones Included:	Yes
National Coordinating Agency:	National Ozone Units

PROJECT SUMMARY

The project will phase out 28 ODP MT of CFCs by replacing 12 CFC based centrifugal chillers in 4 countries in the Eastern Europe and Central Asia Network; Croatia, The Former Yugoslav Republic of Macedonia, Serbia and Montenegro and Romania. The sites selected cover a variery of sectors: a hospital, a bank, industry, shopping centers and public buildings. The project includes 60% of the costs for the replacement of 12 centrifugal chillers supported by 40% counterpart co-financing (US$ 2,220,000), costs for administering the funds (US$ 100,000), technical assistance (US$ 100,000), funds for fostering local initiatives for chiller replacement (US$ 50,000) and funds for organizing a regional workshop at the end of the demonstration project to exchange information on the results of the demonstration project with other countries in the region.

Impact of project on country's Montreal Protocol obligations:

The project will demonstrate the value of early chiller replacement and phase out 28 ODP MT of ozone depleting substances in the chiller sub-sector

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Reviewed by:	Mr. C. Murdoch	**Date:** October 2005

1. Project objective

The project aims at demonstrating the value of replacing a number of CFC-based centrifugal chillers into non-CFC alternatives in four European Countries operating under Article 5 of the Montreal Protocol on substances that deplete the ozone layer namely Croatia, Serbia Montenegro, Romania and Macedonia (herein refered to as Balkan countries).

- The main objectives of the proposed project are to assist countries:
- To reduce their consumption of ozone depleting substances (ODS) as required under the Montreal Protocol
- To improve the energy efficiency of liquid chillers, demonstrating actual energy savings resulting from the replacement of 12 old CFC chillers in the 4 in the EECA region and reducing greenhouse gas emissions in refrigeration and air conditioning sector.
- The project will specifically facilitate the early replacement of CFC chillers with low-energy efficiency to non-CFC chillers with a high-energy efficiency.

Based on intermediate findings of the demonstration project, UNIDO will develop a replacement policy for the remaining CFC chillers in the 4 countries in cooperation with the competent Government Bodies and stakeholders.

2. Background

The Fourteenth Meeting of the Parties (MOP), in its decision XIV/9, decided to request the Technology and Economic Assessment Panel (TEAP) to collect data and assess the portion of the refrigeration service sector made up by chillers and identify incentives and impediments to the transition to non-CFC equipment and prepare a report; and to request the TEAP to submit the report to the Open-ended Working Group meeting (OEWG) for their consideration. The sixteenth MOP considered the recommendations of the OEWG and decided to request the Executive Committee through decision XVI/13 to fund additional demonstration projects to demonstrate the value of replacement of CFC-based chillers. In the light of decision XVI/13 of the Parties, the Executive Committee decided to establish a funding window amounting to *US $*15.2 million for the chiller sector in 2005 and requested Secretariat to prepare a study on criteria and modalities on how a regional fund for the chiller sector might come into operation to be considered at the Fourty Sixth Meeting.

The Fourty Sixth Meeting of the Executive Committee considered the report of the Secretariat and adopted decision 46/33, which invites the implementing agencies to submit to the Fourty Seventh Meeting of the Executive Committee project proposals to demonstrate the feasibility of and the modalities for replacing centrifugal chillers through the use of resources outside the Multilateral Fund and which could be replicated in other countries.

The general conditions for such investment demonstration projects are:

- Ensure a regional and geographical balance of projects
- Consumption of ODS for servicing of chillers represents a good portion of the overall servicing consumption of a country
- The relevant countries have enacted and are enforcing legislation to phase out ODS
- The project intends to use financial resources outside the Multilateral Fund such as national programmes, GEF funding or other sources. The credibility of those financial resources has to be demonstrated before disbursement of funds approved under the Multilateral Fund can commence;
- The total funding per chiller is determined using a mathematical and/or business model, taking into account relevant decisions of the Executive Committee, such as the share of transitional ownership
- The maximum Multilateral Fund grant for a particular country is US $1,000,000; for regional projects
- The project proposal includes a general strategy for managing the entire CFC chiller sub-sector in the countries concerned.

3. Introduction

3.1. Status of Country's Montreal Protocol Obligations

Croatia, Macedonia, Romania and Serbia and Montenegro are very well advanced in implementing the work plan for meeting their obligations under the Montreal Protocol on Substances that Deplete the Ozone Layer. The 4 countries have ratified the Montreal Protocol and all its amendments except for Romania with the pending ratification of the Beijing amendment. However, the ratification of the Beijing Amendment in Romania is expected to be approved by the end of 2005. All 4 countries have a Law for banning the import and export of ODS and ODS containing equipment and have consequently Introduced a licensing system controlling the ODS imports.

The servicing sector is the largest sub-sector constituting the CFC consumption in the Balkan Countries, which is being taken care of through the implementation of the refrigerant management plans and the terminal phase out management plans.

The servicing of chillers as a percentage of the total CFC consumption in the servicing sub-sector is presented in table 1below:

Table 1: Reported CFC consumption in 2004 (kg)

Country	Refrigeration service sub-sector	Chiller servicing Consumption
Croatia	78,830	6,805
Macedonia	108.8	6,030
Romania	104.75*	4,400
Serbia and Montenegro	342,000	5,230

*estimated CFC consumption in the servicing sector

3.2.Chiller Sub-Sector Background

The number of centrifugal chillers in Balkan countries is relatively small for several reasons; There is a limited number of large buildings in the Balkan countries, out of which only a few have central air conditioning systems. Most of the central air conditioning systems use reciprocating chillers with R22 for cooling capacities from 20 to 500 kW. For large capacities usually two or three chiller units are used. Since1985, screw compressors with R22 slowly became available as alternatives to reciprocating compressors in the range from 300 kW to 1000 kW, and to centrifugal chillers for bigger capacities.

There were a few manufacturers of reciprocating chillers in the former Yugoslavia. However, after 1991 the new independent countries stopped chillers' production as they couldn't be competitive on the open market. The four Balkan countries have since then been totally importing all types of chillers mostly from developed countries. Therefore, since 2000 the imported chillers are charged with HFC refrigerants, usually R407C in reciprocating, scroll and screw chillers, and R134a in screw chillers.

Almost all centrifugal chillers in four Balkan countries excluding Romania are imported from US companies York, Carrier and Trane. In the meantime some old CFC centrifugal chillers are replaced with new non-CFC ones.

The moderate continental climate in the four countries influences the operating hours of the chillers. Typically, air conditioning systems run during the period May to September and for a period of about 6 to 12 hours per day. The annual operating time of chillers in air conditioning systems is therefore estimated at 700 to 1800 hours/year.

On the other hand, the operating time for industrial chillers varies depending on the production process. It is estimated that the average operating time of chillers in most factories is between 2000 and 8000 hours/year.

Chillers suffer from low quality maintenance for all types of chillers especially centrifugal ones and lack of preventive measures to avoid leakage. Only a few personnel are trained by brand name companies in the time of chillers purchase, i.e. 20 to 30 years ago. Therefore, today's new personnel are not versed in proper maintenance and servicing. On the other hand, many owners don't allow money for regular maintenance, spare parts and in time service in order to "save money" that is wrong. For many owners it is too expensive to call a company which is specialized in service of centrifugal chillers. Consequently, many chillers are in a poor technical condition working with lower COP, having frequent failures and a high refrigerant leakage rate (up to 100%). The prove is evident looking at building facade where many individual split systems air conditioners are built even a central air conditioning system exists. This trend must be prevented because central air conditioning systems are more efficient and with longer life than individual air conditioners.

The operation of chillers is dependent on the cooling water coming from the cooling tower. All the time fresh water (about 3 to 5 % of re-circulated water) must be added to the cooling tower. This fresh water must be under previous chemical treatment that is not practiced in regular operation. As a result there is a sediment and scale in the condenser's tubes causing many problems: less heat transfer, higher condensing pressure, hard operation of compressors and more probable failure.

Inventories of centrifugal chillers

UNIDO initiated preparatory project development in the four Balkan countries through preparation of a survey in the chiller sector attempting to create an inventory of CFC based centrifugal chillers in each country outlining the ownership, age groups, types, charge and releases for each chiller. Results of the survey are summarized below:

Table 2. Key data on the chiller population in Croatia, Serbia and Montenegro, Romania and Macedonia

	Croatia	**Serbia&M**	**Romania**	**Macedonia**	**Overall (or average)**
Number of chillers	22	34	7	23	**86**
CFC charge total, kg	29,343	20,265	9,000	15,100	73,708
CFC charge per unit, kg	1,334	596	1,286	657	857
Leakage total, kg/y	6,805	5,230	4,400	6,030	22,465
Leakage per unit, kg/y	309	154	629	262	261
Capacity average, kW	1,115	1,280	1,100	1,090	1,150
Operating time, hours/y	2,456	3,718	2,766	1,430	2,500
Energy consumpt., MWh/y	971	1,264	2,261	566	5,062
COP average	3.67	3.40	2.48	3.01	3.25
CO2-eq emission, tCO2/y	75,574	76,074	44,901	58,748	255,296

4. Approach

4.1. General

The key objective of the proposed demonstration projects should be to clearly evaluate and demonstrate the incentives for operators to convert / replace CFC based centrifugal chillers.

As demonstrated by the work carried out by the World Bank in developing its opportunity cost model, it will only be through detailed understanding of these incentives that operators and owners will be persuaded to invest in conversion or replacement activities.

The project is designed to identify all applicable incentives for owners and operators. These fall within 3 principle categories:

- Financial – opportunity cost, energy savings, reduced maintenance
- Operational – process improvement, improved reliability
- Practical – lifecycle replacement, planned reconfiguration,

It has been found in non-article 5 countries that the instigation of basic plant monitoring, including energy consumption, chiller efficiency, operation and control regime often highlights potential process improvements that have significant cost savings potential in terms plant utilisation, energy efficiency and even reduced plant capacity requirements. A key feature of the demonstration project will therefore be to apply rigorous monitoring of chiller installations before and after replacement.

The chiller project will be implemented using strict criteria under which a chiller replacement can be co-funded. The criteria developed and refined by this project will then be used for the national strategy for chiller replacements.

The concept of a revolving fund has been analyzed, but is not included in this proposal. Results of the cash flow analysis of a revolving fund are presented as annex V to this document.

An opportunity cost model will be applied in each counterpart and this will take into account local factors such as energy costs, cost of debt finance, and operator's access to finance and other and average life cycles of plant. It will also be important to take account of and technical and economic know how of operators when considering how to validate the models to owners, operators and investors.

The incentive for chiller replacement will be a demonstrated based on a rate of return of investments in the range of 30% through an innovative financial mechanism consisting of a national component through green loans, funds from the MF, in kind contribution and provider guaranteed energy efficiency.

4.2. Outputs

The outputs of the demonstration project will include the technical selection of the most suitable replacement options, the development of appropriate monitoring and evaluation protocols and the development of appropriate financial mechanisms for co-funding future projects throughout the region.

Output	Activities	Measures
Demonstration: More chillers are converted to ODS free technology in the region.	• Selection of four chiller replacements according selection criteria with the best demonstrative value • Detailed energy and performance monitoring • International tender on conversion technology for these four sites • Contracting the conversion and monitoring its progress • Publishing the results from the conversions	chillers converted monitoring output and analysis
Awareness: Governments, end users and manufacturers are	• Translation of results from the demonstration projects into Local language	regional conference

aware of the economic incentives from chiller replacement.	• National workshops with institutions, manufacturers and end users • Regional conference for all Local countries on the results of the demonstration projects • Publication of proceedings from the conference • Promotion of chiller replacement through media	user survey more suppliers enquiries
Environmental Impact: R11 and R12 is recovered and reused. Reduced CO_2 emissions	• Provision with R&R equipment (R&R unit for R12, liquid pump for R11 and necessary storage devices)or including mandatory recovery of refrigerant in the contracts for the demonstration sites • Arranging for gas distributors or equipment supplier to buy the recovered refrigerant • Monitor progress of reuse of refrigerant	28,000 kg CFC refrigerant recovered and available to service sector

5. Site Selection Criteria

The demonstration project will be based on installation of high efficiency non-CFC chillers with an average rated energy consumption of 0.60 kW per capacity of refrigerated ton.

The technology selected must minimize impact on global warming be technically feasible for the application, environmentally sound and economically viable.

The basic estimates factors used to develop the details of the proposal are as follows:

- Average chiller capacity and efficiency
- Baseline electricity consumption
- Electricity consumption with new chillers
- Cost of electricity
- Estimated running time
- Baseline water consumption
- Cost of water
- Water consumption with new chillers
- Refrigeration demand over time
- Refrigerant leakage
- Technical condition
- Solvency of company
- Hold legal status of the buildings
- Availability of qualified technicians
- Average remaining life
- Owners prepared to co fund

6. Project site selection

The following sites were selected in consultation with the national ozone offices taking into account the criteria indicated above:

6.1. Croatia (4 sites)

Site	**Chiller model**	**Cooling capacity kW**	**COP**	**Age**	**Refrigerant charge Kg**	**Refrigerant leakage kg/year**
DINA Petrokemija	York LTD 76+M326A	1,400	1.750	1982	20,000	6,000
Opca Bolnica Osijek	Trane ECVGA-20	700	4.000	1981	272	30
“ SRDJ” Galeria	Carrier, 19DG	1,080	2,500	1971	250	40
Ministry of Economy	York MTD 85	1,050	4.300	1981	450	35

6.2. Serbia&Montenegro (5 sites)

Site	Chiller model	Cooling capacity kW	COP	Age	Refrigerant charge kg	Refrigerant leakage kg/year
Birografika	Carrier 19DH6	815	3.25	1973	400	250
VMA Hospital	Carrier 19EB	3,000	4.22	1980	1,362	300
RT-CG	Carrier 19 DH	930	3.72	1979	280	50
Viskoza KORD	Mitsubishi T12105-1	1,512	3.69	1965	560	100
Aerodrom	Carrier 19D	800	3.40	1978	300	150

6.3. Romania (1 site)

Site	Chiller model	Cooling capacity kW	COP	Age	Refrigerant charge kg	Refrigerant leakage kg/year
Chimcomplex	30THMB-4000-2 Russia	2,326	1.86	1990	3,000	1,000

6.4. Macedonia (2 sites)

Site	Chiller model	Cooling capacity kW	COP	Age	Refrigerant charge kg	Refrigerant leakage kg/year
National Bank of RM	Carrier 190 G	900	2.80	1976	400	150
OHIS – OCI	York TD120	1,700	3.40	1974	900	350

7. Comparison of Available Replacement Technologies

7.1. Available Technologies

The components of a chilled-water system include a chiller, air-handling units with chilled-water coils, chilled-water loop(s) with chilled-water pump(s), a condenser water loop, condenser water pump(s), and a cooling tower. Optimizing chilled-water systems requires careful integration of these components. The main components of a water chiller are compressor, evaporator and condenser (water-to-refrigerant heat exchangers). The chiller is the heart of the system and generally the single largest energy user in non-industrial buildings.

Replacement options depend on the size of cooling capacity range, energy efficiency, environmental data, safety, flammability etc.

A - Chiller technologies alternatives

Compressor	**Typical Capacity Range**	**Refrigerant Alternative**
Centrifugal	> 700 kW (200 ton)	HCFC-123, HFC-134a, HCFC-22
Screw	200-1500kW (50-400 ton)	HFC-134a, HCFC-22, HFC-407C HFC-410A , R-717
Scroll	75-300kW (20-80 ton)	HFC-134a, HCFC-22 HFC-407C, HFC-410A
Reciprocating	75-500 kW (20-150 ton)	HCFC-22, HFC-407C, HFC-410A, R-717

B - Absorption technologies

	LiBr-H20	NH3-H2O
ODP	0.0	0.0
GWP	0.0	<1
COP	≈1.0	≈1.0
Cooling capacity	> 10 kW	> 0.1 kW

Modern chillers use about 35% less electricity than average chillers produced just two decades ago and the best chiller today uses half the electricity of the average 1976 chiller.

The performance of a chiller can be specified using full-load or part-load efficiency (kW/ton) depending upon the application. Part-load efficiency (IPLV) is preferred for more variable loads accompanying variable ambient temperature and humidity that is more common situation.

Full-load is appropriate where chiller load is high and ambient temperature and humidity are relatively constant (e.g., for baseline chillers). In the following table recommended and best available chiller efficiencies are given published in 2004 by US Department of Energy - Federal Energy Management Program.

Compressor Type and Capacity	**Part Load Efficiency IPLV (kW/TR)**	
	Recommended	**Best Available**
Centrifugal 150 – 299 tons	0.52 or less	0.47
Centrifugal 300 – 2,000 tons	0.45 or less	0.38
Rotary Screw ≥150 tons	0.49 or less	0.46
Compressor Type and Capacity	**Full Load Efficiency (kW/TR)**	
	Recommended	**Best Available**
Centrifugal 150 – 299 tons	0.59 or less	0.50
Centrifugal 300 – 2,000 tons	0.56 or less	0.47
Rotary Screw ≥150 tons	0.64 or less	0.58

US Department of Energy - Federal Energy Management Program, 2004 (1 ton (refrigeration) = 3.517 kW)

The higher efficiency of today's chillers is a result mostly of the improved new control of chiller unit and optimisation of the cooling system including pumps, fans and cooling tower. It is common for modern chillers to incorporate Variable Speed Drive (VSD) systems, which allows the capacity to be varied by varying compressor speed and, in the case of centrifugal compressors, fine tuning of inlet vanes to maintain the optimum compressor efficiency at all loads.

The VSD control is recommended for chilled water and condenser water pumps, as well as cooling fans. The payback of investment in VSD control varies from 1 to 5 years.

7.2. Alternative Refrigerants for Chillers

A –Basic Parameters of Available Refrigerants

	CFC-11	**CFC-12**	**HCFC 22**	**HCFC 123**	**HFC 134a**	**HFC 407C**	**HFC 410A**	**R717 Ammonia**
ODP	1.00	1.00	0.055	0.02	0.0	0	0	0
GWP	4,600	10,600	1,700	120	1,300	1,700	2,000	<1
Atmospheric life (years)	45	100	11.9	1.4	13.8			
Safety group	A1	A1	A1	B1	A1	A1	A1	B2
Flammability LFL	none	None	none	None	None	none	None	15
COP (*)			6.35	6.78	6.27		5.95	6.66
Compressor type (**)	4	1, 2, 3, 4	1, 2, 3, 4	4	1, 2, 3, 4	1, 2, 3	1, 2, 3	1, 2, 3

* *Ideal cycle at condensing temperature of 40.6°C and evaporating temperature of 4.4°C*

** *Compressor types: 1-reciprocating, 2-scroll, 3-screw, 4-centrifugal*

B - Basic Performance Parameters of Alternative Plants:

This includes the comparison of the existing and possibly the new refrigeration plant. The comparison is made under identical performance requirements and plant conditions.

Comparison of performance figures:

Description	unit	CFC	134a	Ammonia	Ammonia / SIS
Performance rating	TR	560	560	560	310
Energy Consumption	kW	465	392	369	321
Connected Load	kW	500	550	500	367
COP (Compressor)		4,21	4,21	5,27	5,27
Condenser rating	kW	2,475	2,475	2,475	0
Chiller water volume	m^3/h	304	304	247	247
Ventilator rating	kW	13	13	13,3	13,3
Connected load	kW	15	15	14,7	14,7
Peripherals and pumps	kW	58	58	60	60
Connected load	kW	74	74	77	77
total connected load	kW	589	639	458	458
consumption	kW	546	475	395	395
main system COP		3,66	3,66	5,07	5,07
daily average refrigeration load	kWh	18894	18894	18894	18894
daily el. consumption	kWh	4849	4491	4234	3726
Water requirements	m^3/h	12.0	12.0	12	10,1
annual electricity costs	US$	106193	98353	92725	81599
annual water costs	US$	27740	27740	27740	23024
leakage rate	%/a	15-30	4	0	0

The newest chiller systems can provide up to 38% savings in electricity and 28% in water consumption.

The project will clearly demonstrate that economic incentives combined with promotional efforts will speed up and enhance the terminal phase out of CFC for chillers very quickly. Without such efforts, the sector will be at critical stake for many following years. One important indicator for decision making will be the price for CFCs. In the midterm only a drastically reduced demand and market for CFCs will make it financially nonviable.

8. Selection of the technology

8.1. Direct project impacts

The actual amount of CFC eliminated will depend on the number of chillers replaced, the size of chillers, leakage rate, age, etc. The project impact is calculated as the sum of the volume of the refrigerant leakage for the chillers being replaced.

8.2. Indirect impacts

The replacement of the existing chillers with energy efficient chillers will result in significant savings in energy consumption. This energy efficiency would lead to a savings in emissions of carbon dioxide released during the generation of electricity.

In section 6 above, the quantity and leakage of CFCs and CO2 emissions from the old CFC centrifugal chillers are presented. By replacing the CFC chillers with new non-CFC chillers, 30 ODP tons will be eliminated. If the new chillers are 40% more efficient, the CO2 emissions associated with energy consumption of chillers (indirect emission) can be reduced by the same amount as well as the CO2-equivalent emission of CFC leakage (direct emission) and from the refrigerant itself.

The average energy efficiency benefits of the replacement of one chiller are demonstrated below.

CO2 abatement benefit from energy saving

	Existing chiller	New chiller
Cooling Capacity, TR (kW)	300 (1055)	300 (1055)

Energy Consumption (kW/TR)	1.0	0.60
Operating Hours (hrs/year)	2,000	2,000
Energy Consumption (kWh/year)	600,000	360,000
Energy Saving (kWh/year)	-	240,000
CO2 intensity of power sector (kgCO2/kWh)	0.8	0.8
CO2 Emission (tCO2/year)	480	288
Reduction of CO2 emission per year		192

Climate change benefit from refrigerant substitution (Chiller 300 TR)

	Existing chiller	Existing chiller	New chiller
Refrigerant	R11	R12	R134a
Leakage average at old chiller (kg/year)	250	150	8
GWP	4,600	10,600	1,300
CO2-eq emission (tCO2/year)	1,150	1,590	10
CO2-eq reduction (tCO2/year)	1,140	1,580	-

The total annual CO2 reduction for a 300 TR R11 chiller is 1,140 tCO2/year; while that for a R12 chiller: 1,580 tCO2/year. 12 chillers are being replaced through the demonstration project is approximately 17,680 tCO2/year.

In view of the data provided regarding the various refrigerant and taking into consideration the safety issues relating to the ammonia refrigerants as well as the national legislation in the 4 countries, all companies opted for the conversion to HFC134a as refrigerant.

Wealth Analysis of the different solutions R22, R134a, R717.

	R22	1	2	3	4	5	**R134a**	1	2	3	4	5	**R717**	1	2	3	4	5
1. ODP	0.05	Bad X				good	0.0	bad				good X	0	bad				good X
2. GWP	1700	X					1300		X				0					X
3. COP	0.7			X			0.7			X			0.9					X
4. COSTS Initial: Refrigeration system	Screw/ Turbo reference					X	Screw/ Turbo 18%	X					Screw/ Piston 10 %				X	
Handling: Refrigerant	3.0 $/kg.				X		16 (8) $/kg.		X				0.7 $					X
Lubricants	20.0$/5 L					X	60.0 $ / 5L	X					45.0$/5L		X			
Spare parts (for 15 years).	8000$		X				10 000 $	X					3000.0$				X	
5. REFRIGERANT DEPENDENCY	imported	X					imported	X					imported.					X
6. HANDLING	Reference					X	20%	X					< 20%		X			
7. SECURITY: Alarm system					X					X						X		
Forced ventilation						X						X		X				
Leakage detector	500.0$		X				500.0$		X				0.0 $					X
Other						X						X	250.0$	X				
8. TRAINING						X	5 days		X				6 days	X				
9. LIFETIME OF EQUIPMENT	30 years turbo 20 years screw			X		X	30 years turbo 20 years screw			X		x	30 years					X

Table 1: R22, R134a, R717

Wealth Analysis of the different solutions R407c and R123.

	R407c	1	2	3	4	5	**R123**	1	2	3	4	5
1. ODP		bad				good X	0.02	bad	X			Good
2. GWP	1610	X					1300		X			
3. COP	0.7			X			0.6					X
4. COSTS Initial: Refrigeration system	Screw 12 %			X			Screw/ Turbo 20 %	X				
Handling: Refrigerant	24$/kg	X					10 $/kg.		X			
Lubricants	60$/5L	X					60 $/5L	X				
Spare parts (for 15 years).	10 000$	X					10 000 $	X				
5. REFRIGERANT DEPENDENCY	imported	X					imported	X				
6. HANDLING	20%	X					0 %					X
7. SECURITY: Alarm system				X						X		
Forced ventilation						X			X			
Leakage detector	500.0 $		X				500 $		X			
Other						X						X
8. TRAINING	6 days	X					2 days				X	
9. LIFETIME OF EQUIPMENT	20 years			X			30 years turbo					X
							20 years screw			X		

Table 2: R407c, R123

9. Calculation of Costs

Incremental Cost Analysis

Information barriers would be removed through technical workshops and public awareness program. The estimated cost of individual project components and the incremental cost are shown in tables below.

Calculated (estimated) costs for replacement of a chiller with cooling capacity 300 TR (1,036 kW) to 500 TR

Investrnent costs (per chiller)	US$
Chiller	150,000
Installation and site preparation	30,000
Maintenance contract	15,000
Procurement / shipping / insurance	5,000
Total	200,000

For the same cooling capacity the suppliers offer a chiller with different size of evaporator and condenser and many accessories which influence the price. In principle, bigger sizes of evaporator and condenser give more efficient chiller. An improved control increases energy efficiency, especially part load efficiency up to 0.35 kW/TR if a VSD is built in (at additional cost of about 25,000 US$). This contributes to a more reliable chiller operation and long life as well.

Cost of energy saving

	Existing chiller	New chiller
Cooling Capacity (TR)	300	300
Energy Consumption (kW/TR)	1.0	0.60
Operating Hours (hours/year)	2,000	2,000
Energy Consumption (kWh/year)	600,000	360,000
Electricity Cost (US$/kWh)	0.10	0.10
Annual Cost of Energy (US$/year)	60,000	36,000
Cost of Energy Saving (US$/year)		24,000

Due to the short operating hours of chillers in the region, the simple payback (without discount rate) for a chiller replacement is more than 6 years. For the same conditions as above in the following table the cost of energy saving is calculated depending for different operating time and electricity cost.

Cost of Energy saving (US$/year) depending of operating hours and electricity cost

Electricity Cost (US$/kWh)	Operating Hours (hrs/year)			
	1,000	2,000	4,000	6,000
0.07	8,400	16,800	33,600	50,400
0.10	12,000	24,000	48,000	72,000
0.12	14,400	28,800	57,600	86,400

A project implementation team should be established for monitoring, supervision of chillers installations, verification etc.

The incremental cost for the demonstration project where 12 CFC centrifugal chillers will be replaced with repayment in duration of 5 years is presented in the table below.

Incremental cost, replacement of 12 chillers (3 years project)

	Baseline	Alternative	Increment
Environment benefit			
Reduction ODS tons		8.0	8.0
Reduction tCO2-eq/yr		136,000	136,000
Costs (US$)			
Capital costs	0	3,400,000	3,400,000
Fund administering	0	100,000	100,000
Technical assistance	0	100,000	100,000
Local initiatives	0	50,000	50,000
Energy consumption costs	1,800,000	1,080,000	-720,000
Regional Workshop	0	50,000	50,000
Total	1,800,000	4,780,000	2,980,000

In the incremental costs there are components to administer the fund (disbursement of loans and repayment), organizing of bidding to purchase chillers, technical assistance to chiller users, training, supervision of chillers installations, verification of equipment, monitoring of project implementation, assistance in development and implementation of local chiller initiatives and dissemination of information.

Project Budget

	Total Project Budget	MLF funding	Co-Funding (40%)
Cost of Chillers	US$ 3,200,000	US$ 1,920,000	1,280,000
Administering funds	US$ 100,000	US$ 100,000	0
Technical assistance	US$ 100,000	US$ 100,000	0
Preparation of local initiatives to replace chillers	US$ 50,000	US$ 50,000	0
Regional Workshop for Information Dissemination on results of the Demonstration Project	US$ 50,000	US$ 50,000	0
Contingency	US$ 350,000	US$ 222,000	US$ 128,000
Total	US$ 3,850,000	US$ 2,442,000	US$ 1,408,000

	Total Project Budget	MLF funding	Co-Funding (40%)
Croatia	1,427,250	899,250	528,000
Macedonia	508,750	332,750	176,000
Romania	701,250	437,250	264,000
Serbia and Montenegro	1,212,750	772,750	440,000
Total	3,850,000	2,574,000	1,408,000

10. Financing options

Owners of the selected project sites were contacted by the national ozone units to obtain their commitment for co-financing. While some had the money insufficient money which withheld their replacement plans, others needed to allocate the money needed for the replacement. For that many of them are considering loan or leasing options. The percentage of co-financing was also discussed. Companies are willing to provide 40% co-financing.

The financial mechanism consists of the following components:

1. Counterpart investment
2. In kind contribution (national)
3. National Co- financing through green loan from a energy fund
4. Contracting (national or international)
5. Provider guaranteed energy efficiency (reference list)
6. International co-financing through GEF and/or CDM mechanism
7. Funds from the MF

A conversion would cost an owner around 14,5 % interest for a three years commercial credit. Taking the low inflation rate of 6,3 % in consideration, the credit costs 8 %.

Taking also in consideration that the energy savings may vary by 50 % from case to case, the IRR of the investment should be significantly higher than the rate of debt and reach a minimum of 15 % to sufficiently cover the economic risk. Especially in cases, where the remaining lifetime of chillers is 17 years and more, only the investment in the most modern and energy efficient technology can gain an acceptable financial return.

Without project, the internal rate of return (IRR) for the conversion would be lower or equal the average market discount rate. It is very unlikely that in such case the owners will give priority to the replacement of chillers before other investments with a higher rate of return. Even in the case of higher efficiencies, such as 0.59 kW/TR for new chillers, the rate of return barely achieves the recover of the debt.

In order to initiate the conversion project, an initial grant of around US$ 2,4 million will be requested. This amount will be used to establish a revolving fund which will, in the first instance, finance the conversion of 12 chillers as a demonstration project. After a lapse of 11 months the pilot project will be evaluated to ascertain its success. If the project is found to be working according to estimate, a second phase will be initiated where a further 80 chillers may be considered for conversion.

Incorporation of international chiller manufacturers

Manufactures of centrifugal chillers can play a vital role in this project. Usually they are well aware of the situation of the possible client for a chiller replacement. In a Memorandum of Understanding the UNIDO will formulate the cooperation with the large chiller manufacturers like York, Grasso, Carrier, and Trane.

The regional approach is given through the dissemination and translation of the results from the demonstration projects and the national financial mechanism to all European countries. The conference will be organized right after the demonstration projects had been conducted.

Representatives of the suppliers in the European region were contacted. They all showed interest to participate in the chiller demonstration projects offering various options from giving discounts to options for leasing chillers and "Energy Savings Performance Contracting" (ESPC) which is to repay the cost of the chiller over several years by paying the energy saving cost. In these cases a bank guaranty is required, it is suggested that a governmental institution could support and provide a guaranty because the interest rates of banks in Balkan countries are high (more than 10%) and as guaranty a mortgage with double than real value is required. Formal offers in this connection will be provided through the process of competitive bidding through which selection will take place.

In the sub-projects where large energy saving is expected, an ESPC purchase model should be implemented. An ESPC allows an activity the flexibility of purchasing new energy efficient chillers and systems with no up-front cost. At first, measurement of energy consumption (COP) of old chiller must be carried out. After installation of new more energy efficient chiller and measurement of energy consumption of new chiller, the purchaser re-pays to the supplier (or to ESCO contractor) cost level of energy saving. The measurements have to be verified by a third party, in this case an expert appointed by UNIDO.

Based on the results of the project, a replacement policy for the remaining chillers will be prepared attempting to utilize funds from the Global Environment Facility and possibly preparing a CDM project. The policy will investigate for other possibilities of co-financing from national energy agencies or national energy conservation funds such as :

- Serbia&Montenegro: Energy Efficiency Centre, within Ministry of Mining and energy
- Romania: Romanian Agency for Energy Conservation, within Ministry of Economy and Commerce
- Croatia: Hrvatska Elektroprivreda - ESCO
- Macedonia: Department of Energy, within Ministry of Economy

11. PROJECT COSTS

The total project cost is estimated at US$ 2,442,000.

The Incremental Capital Costs of US$ 2,220,000 include capital investments required.

A contingency of US$ 222,000 equal to 10% of the capital equipment cost is included to cover unforeseen expenditure.

Implementing agency support costs of US$ 183,150 are 7.5% of the total grant request.

12. IMPLEMENTATION

The project will be implemented according to the rules and procedures of UNIDO, under the management of the backstopping officer of UNIDO, in close cooperation with the counterpart company. The Ozone Unit of the Ministry of the Environment in each country will do all necessary local coordination and control.

Suitably qualified and experienced consultants will be appointed and fielded by UNIDO, to substantively assist and supervise the technical aspects of the conversion process, to perform troubleshooting and to provide assistance in specialized product redesign work. The respective job description(s) will be prepared on approval of the project.

The detailed Terms of Reference for the supplies and services to be provided under the project will be elaborated after project approval and sent to the company for his review. After competitive bidding, performed by UNIDO in accordance with UNIDO's financial rules and procedures, a General Contractor will be appointed by UNIDO for the supply of the project equipment (production equipment, etc.). Training and production expertise is likely to be provided by individuals who will be separately contracted by UNIDO.

The final equipment specification and work plan can only be elaborated after approval of the basic approach for project implementation by the MFMP.

Permission from local authorities for the introduction of the new technologies under this project will be obtained by the counterpart, who will also be responsible for the compliance of the new technologies with the established national standards.

Having accepted the conversion of its plants to the application of non-ODS technologies under this project, the counterpart, shall be committed to provide the following inputs:

- All activities and costs related to the construction work needed (including the provision of technical infrastructure) to accommodate the new technologies introduced under this project;
- Technical staff, local labor as required by the General Contractor;
- Provision of tools, transportation and lifting equipment as required;
- Provision of materials, utilities, services, manpower, etc. related to commissioning, start-up, trial runs, prototyping and testing;
- Local transport, communication and secretarial facilities for the General Contractor's and UNIDO's staff involved in the project's implementation;
- All other expenses not included in this Project Document and not covered by the budget approved by the Multilateral Fund for the Implementation of the Montreal Protocol.

The General Contractor will elaborate the specification of these works after project approval and the necessary site inspection. Thus, the costs of construction work can be specified only after appointment of the General Contractor and finalization of the equipment list. The relevant construction work shall be arranged by the counterpart under the supervision of the General Contractor and in line with the established milestones for this project

UNIDO as Implementing Agency has the necessary experience and capabilities for the successful implementation of projects at enterprise level. Upon approval of the project by the MFMP the whole budget will be transferred to UNIDO. Any substantive or financial deviation from the approved project is subject to approval by the MFMP and UNIDO.

13. PROJECT MONITORING MILESTONES

Milestone	Month, after approval	Results			Remarks
		Achieved	Not achieved	Delay	
Implementation Agreement submitted to beneficiary	2				
Implementation Agreement signed	2				
TOR for equipment (Refrigerant equipment and foaming machines)	2				
TOR for equipment cleared by beneficiary	2				
Bids requested	2				
Bids received, evaluated	4				
Contract for equipment supply signed	4				
Equipment delivered	8				
Commissioning and trial runs	8				
Decommissioning and destruction of replaced equipment	2				
Submission of project	36				

Annex I – Croatia

Due to time constraints and problems during the data collection such as owners not allowing the consultant to access the sites, the survey in Croatia included only 22 CFC centrifugal chillers. It is to be noted though that the number of CFC chillers reported in the TEAP report on chillers (2004) is 54 CFC centrifugal chillers. A few of these chillers have been already replaced with new non-CFC chillers or retrofitted during the last year. It is recommended to allocate some funds in the demonstration project to prepare a more comprehensive survey in Croatia, which will facilitate the formulation of an inclusive replacement policy.

The refrigerants used in the surveyed chillers are CFC11 and CFC12 and their age is in the range of 14 to 34 years. One chiller of specific interest was that at DINA Petrokemija, a petrochemical industry, with a power of 1,400 kW and a refrigerant charge of 20,000 kg.

Table I. Detailed information on the surveyed chiller population in Croatia

No	Owner	Manufac-tured	CFC	Charge kg	Leakage kg/y	Power kW	COP	Operating hours/y	Energy MWh/y
1	DINA Petrokemija (1)	1982(83)	CFC-12	20,000	6,000	1,400	1.750	8,160	6,400
2	DINA Petrokemija (2)	1980(82)	CFC-500	2,000	50	3,700	4.500	8,400	6,800
3	Zagrebcanka	1975	CFC-11	159	5	974	4.450	1,512	257
4	INA	1980(83)	CFC-12	681	30	1,150	3.100	4,320	1,144
5	Robna kuća "Dobri"	1971(75)	CFC-11	300	45	1,280	3.680	1,320	460
6	"SRDJ" - Galerija	1971(72)	CFC-11	250	40	1,080	2.500	1,740	749
7	INA Administracija	1986(87)	CFC-12	372	50	1,340	4.100	1,400	420
8	Vjesnik	1978(79)	CFC-11	350	150	1,400	4.000	3,000	400
9	Opca Bolnica Osijek	1981	CFC-12	272	30	700	4.000	3,240	507
10	Opca Bolnica Osijek	1981	CFC-12	195	20	515	3.430	2,200	162
11	Opca Bolnica Osijek	1984(92)	CFC-12	220	25	620	3.500	2,000	360
12	RK Koteks	1978	CFC-12	450	15	880	4.000	2,700	594
13	RK Koteks	1978	CFC-12	450	15	880	4.000	2,700	594
14	Four Point	1991(92)	CFC-12	372	20	850	3.150	1,170	239
15	Ministry of Economy	1981(83)	CFC-11	450	35	1,050	4.300	1,320	225
16	Ministry of Economy	1982(83)	CFC-12	272	25	545	4.200	1,320	123
17	SC Gripe	1978(79)	CFC-11	450	40	1,150	3.800	300	77
18	SC Gripe	1978(79)	CFC-11	450	40	1,150	3.800	300	91
19	FINA	1977(78)	CFC-11	250	30	700	2.900	1,320	200
20	SAS	1978(79)	CFC-11	400	40	875	4.000	1,600	350
21	SAS		CFC-11	500	50	1,150	3.800	2,000	600
22	RK NAMA		CFC-11	500	50	1,150	3.800	2,000	600

Project Costs - Croatia

	Total Project Budget	MLF funding	Co-Funding (40%)
Cost of Chillers	US$ 1,200,000	US$ 720,000	480,000
Administering funds	US$ 35,000	US$ 35,000	0
Technical assistance	US$ 35,000	US$ 35,000	0
Preparation of local initiatives to replace chillers	US$ 15,000	US$ 15,000	0
Regional Workshop for Information Dissemination on results of the Demonstration Project	US$ 12,500	US$ 12,500	0
Contingency	US$ 129,750	US$ 81,750	US$ 48,000
Total	US$ 1,427,250	US$ 899,250	US$ 528,000

The cost of the chiller replacement at DINA Petrokemja is estimated at US$ 600,000 including cost for performing a feasibility study.

Annex II – The Former Yugoslav Republic of Macedonia

The survey in Macedonia identified 23 CFC centrifugal chillers using CFC-11 and CFC-12. These units are relatively old (20 to 30 years) and part of them is out of use. The main feature of the installations in usage is the large annual consumption of refrigerants, which is due to the advanced level of amortizations. The data shows annual consumption of: 1,700 kg CFC-11 for four aggregates in usage.

The survey of centrifugal chillers in Macedonia shows that a number of these installations are mainly out of use. Some of the enterprises are bankrupt; some of the factories are shot down due to economical disruptions after disintegration of former Yugoslavia:
8 chillers are damaged and should be dismantled.
9 chillers are in standstill (bankruptcy, stopped production, technology change). They are in working condition or could be repaired. Some owners offer them for sale.
6 chillers are in working condition with some problems and should be replaced.

Table II. Detailed information on the surveyed chiller population in Macedonia

No.	Owner	Manufac-tured	CFC	Charge kg	Leakage kg/y	Power kW	Operating hours/y	Energy MWh/y
1	MNT	1976	CFC-11	400	130	367	600	220
2	MNT	1976	CFC-11	400	130	367	600	220
3	MNT	1976	CFC-11	400	130	300	500	150
4	National Bank	1976	CFC-11	400	150	321	1,200	386
5	National Bank	1976	CFC-11	400	150	321	1,200	386
6	Astibo	1978	CFC-11	400	100	321	1,500	482
7	Astibo	1978	CFC-11	400	100	321	1,500	482
8	Astibo	1978	CFC-11	400	100	321	1,500	482
9	Tutunski Komb.	1974	CFC-11	450	150	444	2,000	889
10	Tutunski Komb.	1974	CFC-11	450	150	444	2,000	889
11	OHIS - OCI	1974	CFC-11	700	250	205	1,200	246
12	OHIS - OCI	1974	CFC-11	700	250	205	1,200	246
13	OHIS - OCI	1974	CFC-11	900	350	500	1,440	720
14	OHIS - OCI	1974	CFC-11	900	350	500	1,440	720
15	OHIS - Malon	1979	CFC-12	1,200	500	518	2,000	1,036
16	OHIS - Malon	1979	CFC-12	1,200	500	518	2,000	1,036
17	OHIS - Malon	1981	CFC-12	1,200	500	630	2,000	1,260
18	OHIS - Malon	1981	CFC-12	1,200	500	518	2,000	1,036
19	OHIS - Malon	1979	CFC-12	1,200	1,000	357	2,000	714
20	Hemteks	1985	CFC-11	450	120	333	1,500	500
21	Hemteks	1985	CFC-11	450	120	333	1,500	500
22	Railway Station	1988	CFC-11	450	150	205	1,000	205
23	Railway Station	1988	CFC-11	450	150	205	1,000	205

Project Costs - Macedonia

	Total Project Budget	MLF funding	Co-Funding (40%)
Cost of Chillers	US$ 400,000	US$ 240,000	160,000
Administering funds	US$ 20,000	US$ 20,000	0
Technical assistance	US$ 20,000	US$ 20,000	0
Preparation of local initiatives to replace chillers	US$ 10,000	US$ 10,000	0
Regional Workshop for Information Dissemination on results of the Demonstration Project	US$ 12,500	US$ 12,500	0
Contingency	US$ 46,250	US$ 30,250	US$ 16,000
Total	US$ 508,750	US$ 332,750	US$ 176,000

Annex III - Romania

The policy in Romania before 1990 prohibited the import of equipment from west developed countries. Moreover, since 1990 several CFC chillers were replaced with new non-CFC ones. The survey in Romania therefore identified only 7 CFC centrifugal chillers using CFC-11 and CFC-12. Two of the chillers are installed in Romanian Radio Broadcasting, one of which is out of use, two in Romanian TV and three in an industrial facility, Chimcomplex. All chillers are 20 - 40 years olds and are in a poor technical condition with frequent failures and large leakages.

Table III. Detailed information on the surveyed chiller population in Romania

No.	Owner	Manufac-tured	CFC	Charge kg	Leakage kg/y	Power kW	COP	Operating hours/y	Energy MWh/y
1	Romanian Radio	1987	CFC-11	450	450	582	3.22	990	179
2	Romanian Radio	1987	CFC-11	450	450	582	3.22	990	179
3	Romanian TV	1984 (85)	CFC-11	800	800	1,163	3.69	3,960	1,247
4	Romanian TV	1964 (65)	CFC-11	700	700	1,163	3.06	700	266
5	Chimcomplex	1983	CFC-12	1,800	500	930	1.16	2,160	1,728
6	Chimcomplex	1983	CFC-12	1,800	500	930	1.16	2,160	1,728
7	Chimcomplex	1990 (96)	CFC-12	3,000	1,000	2,326	1.86	8,400	10,500

Project Costs - Romania

	Total Project Budget	MLF funding	Co-Funding (40%)
Cost of Chillers	US$ 600,000	US$ 360,000	US$ 240,000
Administering funds	US$ 10,000	US$ 10,000	0
Technical assistance	US$ 10,000	US$ 10,000	0
Preparation of local initiatives to replace chillers	US$ 5,000	US$ 5,000	0
Regional Workshop for Information Dissemination on results of the Demonstration Project	US$ 12,500	US$ 12,500	0
Contingency	US$63,750	US$ 39,750	US$ 24,000
Total	US$ 701,250	US$ 437,250	US$ 264,000

The cost of the chiller replacement at Chimcomplex is estimated at US$ 600,000 including cost for performing a feasibility study.

Annex IV- Serbia&Montenegro

Due to the ongoing privatization process in the country, some companies did not allow access to information on the equipment volume and its technical data, which they considered confidential and privileged information. The survey in S&M included 34 CFC centrifugal chillers using the refrigerants CFC-11, CFC-12 and CFC-114 installed in commercial complexes, hospitals, hotels and large industrial corporations. The chillers age is 19 to 40 years.

A number of companies closed their production for various techno-economical reasons and were not accessible for the survey. Some of their chillers are in working condition, but at the moment are not in operation. Some chillers are damaged and used for spare parts, these should be dismantled. Operation and maintenance logbooks were not in place in any of the surveyed companies.

Table 4.3. Detailed information on the surveyed chiller population in Serbia and Montenegro

No.	Owner	Manufac-tured	CFC	Charge kg	Leakage kg/y	Power kW	COP	Operating hours/y	Energy MWh/y
1	Aerodrom	1978	CFC-11	300	150	800	3.40	3,360	791
2	Aerodrom	1978	CFC-11	300	150	800	3.40	3,360	791
3	Aerodrom	1978	CFC-11	300	150	800	3.40	3,360	791
4	Birografika	1973(74)	CFC-11	400	250	815	3.25	2,160	542
5	DIN	1972	CFC-11	300	80	440	2.50	6,720	1,183
6	DIN	1972	CFC-11	300	80	440	2.50	6,720	1,183
7	EI – Nis	1983	CFC-11	300	100	800	3.50	5,040	1,152
8	EI – Nis	1983	CFC-11	300	100	800	3.50	5,040	1,152
9	Hotel Yug.		CFC-12	426	80	650	3.00	4,800	1,040
10	Hotel Yug.		CFC-12	426	80	650	3.00	4,800	1,040
11	Hotel Yug.		CFC-12	426	80	650	3.00	4,800	1,040
12	Klinicki centar	1986(88)	CFC-12	989	50	1,850	3.84	1,200	578
13	HTP Milocer	1978	CFC-11	280	90	800	3.40	5,040	1,186
14	HTP Milocer	1978	CFC-11	280	90	800	3.40	5,040	1,186
15	RT-CG	1979(84)	CFC-11	280	50	930	3.72	1,800	450
16	RT-CG	1979(84)	CFC-11	280	50	930	3.72	1,800	450
17	TK Centar	1973	CFC-12	517	100	1,000	3.50	7,200	2,057
18	TK Centar	1973	CFC-12	517	100	1,000	3.50	7,200	2,057
19	Urb. Zavod		CFC-12	326	100	600	3.10	2,400	465
20	Viskoza Energ.	1955	CFC-11	900	300	1,740	3.00	3,200	1,856
21	Viskoza Energ.	1955	CFC-11	900	300	1,740	3.00	3,200	1,856
22	Viskoza Energ.	1955	CFC-11	900	300	1,740	3.00	3,200	1,856
23	Viskoza Energ.	1955	CFC-11	900	300	1,740	3.00	3,200	1,856
24	Viskoza KOD	1965(66)	CFC-11	570	200	760	3.10	2,880	706
25	Viskoza KOD	1965(66)	CFC-11	570	200	760	3.10	2,880	706
26	Viskoza KORD	1965(66)	CFC-114	560	100	1,512	3.69	2,400	983
27	Viskoza KORD	1965(66)	CFC-114	560	100	1,512	3.69	2,400	983
28	Viskoza Lozofon	1965(66)	CFC-114	570	100	1,500	3.50	2,400	1,029

29	Viskoza Lozofon	1965(66)	CFC-114	570	100	1,500	3.50	2,400	1,029
30	Viskoza Lozofon	1965(66)	CFC-114	570	100	1,500	3.50	2,400	1,029
31	VMA	1980	CFC-12	1,362	300	3,000	4.22	8,000	5,687
32	VMA	1980	CFC-12	1,362	300	3,000	4.22	2,000	1,422
33	VMA	1980	CFC-12	1,362	300	3,000	4.22	2,000	1,422
34	VMA	1980	CFC-12	1,362	300	3,000	4.22	2,000	1,422

Project Costs -Serbia and Montenegro

	Total Project Budget	MLF funding	Co-Funding (40%)
Cost of Chillers	US$ 1,000,000	US$ 600,000	400,000
Administering funds	US$ 35,000	US$ 35,000	0
Technical assistance	US$ 35,000	US$ 35,000	0
Preparation of local initiatives to replace chillers	US$ 20,000	US$ 20,000	0
Regional Workshop for Information Dissemination on results of the Demonstration Project	US$ 12,500	US$ 12,500	0
Contingency	US$ 110,250	US$ 70,250	US$ 40,000
Total	US$ 1,212,750	US$ 772,750	US$ 440,000

Annex V – Analysis of a Revolving Fund

Cash flow Analysis Revolving Fund

year	Payback period	Balance owed	Payback	Repayments	Admin cost	Unit repl.	Funds available	Net repayments	Year 1	2	3	4	5	6	7	8	9	10	11	Year 12
1						11	2.200.000	2.365.000	788.333	788.333	788.333									
2	1	3.758.700	-1557490	-592.410	15.661	21	3.938.962	4.234.384		1.411.461	1.411.461	1.411.461								
3	2	3.602.951	-1744380	-592.410	15.661	8	1.591.724	1.711.103			570.368	570.368	570.368							
4	3	3.428.513	-1953710	-592.410	15.661	12	2.162.091	2.324.248				774.749	774.749	774.749						
5	4	3.233.142	-2188150	-592.410	15.661	11	2.148.507	2.309.646					769.882	769.882	769.882					
6	5	3.014.327	-2450730	-592.410	15.661	9	1.506.928	1.619.947						539.982	539.982	539.982				
7	6	2.769.253	-2744820	-592.410	15.661	8	1.476.543	1.587.283							529.094	529.094	529.094			
8	7	2.494.771	-3074200	-592.410	15.661	6	1.230.888	1.323.204								441.068	441.068	441.068		
9	8	2.187.351	-3443100	-592.410	15.661	5	902.074	969.730									323.243	323.243	323.243	
10	9	1.843.041	-3856280	-592.410	15.661	4	685.335	736.735										245.578	245.578	245.578
11	10	1.457.413	-4319030	-592.410	15.661		401.818	0												
12	11	1.025.510	-4837310	-592.410	15.661		362.569	0												
13	12	541.779	-5417790	-592.410	15.661		76	0												
	Totals				187.935		18.607.515	19.181.281	180.262	1.591.724	2.162.091	2.148.507	1.506.928	1.476.543	1.230.888	902.074	685.335	401.818	-39.250	-362.493

Payback rate/a	**-592.410**		
Years	**12**	**Net repayment**	**16.981.281**
Inflation	**1,065**		
SubsInt.	**1,075**		
Intern.Cred.	**12%**		
Units replaced	**95**		