**DRAFT**

**EVALUATION OF CHILLER PROJECTS WITH CO-FINANCING MODALITIES**

Mission Report - Field visit to Brazil

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Prepared for: Multilateral Fund Secretariat- Montreal- Canada

Prepared by: Marta Comte, Independent Consultant

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**INTRODUCTION**

**Scope and objective of the evaluation**

1. The desk study on the evaluation of chillers projects submitted to the 68th meeting of the Executive Committee analyses the effectiveness of eight demonstration projects with a view to improving understanding of progress made, difficulties still being encountered, various attributes and shortcoming of the co-funding mechanisms and project approaches in the implementation of chiller projects. The report concludes that the system of stimuli used to drive replacements has uneven results, it is not working in all countries and where it is working it is not fast enough. It describes a variety of mechanisms, promotions and incentives, which were utilized in the eight demonstration projects. However, initiation of these projects had been slow at the time the desk study was written and therefore progress reporting was limited, postponing the second stage of the evaluation, which includes field visits, until the projects reached a more mature stage of implementation. After consulting with the implementing agencies during the Inter-agency coordination meeting, it was decided the timing was opportune and the Senior Monitoring and Evaluation Officer (SMEO) presented to the 77th meeting of the Executive Committee the terms of references for the second stage of the evaluation for 2017[[1]](#footnote-1), which are annexed to the present report (Annex I).
2. The objective of this evaluation is to collect and analyze information at the field level with the aim of finding an answer to the questions and issues raised in the desk study, especially those related to the functioning of various financial mechanisms. The evaluation examines the demonstration projects and assesses whether sufficient incentives are in place to catalyze replacements without the Multilateral Funds resources, and what problems to expect in both private and public sector in countries where funds for chillers replacements are scarce.
3. This report analyses the findings of the field mission in Brazil. An evaluation team composed an independent consultant and the SMEO visited all four locations included in the conversion project. The team collected information through direct observation and discussions with the building managers, the National Ozone Unit (NOU/ Ministry of Environment (MMA), UNDP Brazil, authorities of Brazil RAC Association and the company Somar Eng. The list of meetings and contacts is annexed to the report (Annex II).

**Background**

1. In 2005 at its 47th meeting the Executive Committee approved US $1 million for the implementation of the “Demonstration project for integrated management in the Chiller subsector in Brazil, with emphasis on the application of energy efficient, CFC free technologies for the replacement of CFC-based chillers” (Annex III). This demonstration project was approved conditional on the provision of matching funds for implementation of all other activities related to the improvement of energy efficiency in buildings. It aimed at replacing at least 12 chillers.
2. The co-funding was ensured by the Global Environment Facility (GEF) which was funding a larger project, executed by UNDP: ‘Market Transformation for Energy Efficiency in Brazil’ ((UNDP/BRA/09/G31) and by the Inter-American Development Bank (IDB).
3. This GEF project had the overall objective to influence, transform, and develop the market for the operation of energy efficiency in various buildings in Brazil, leading to more sustainable and less carbon-intensive consumption, creating at the same time warranty mechanism models in order to facilitate obtaining funds from banks or other funding institutions. The project BRA/09/G31 had six outcomes (see Annex IV). Outcome 3 included the activities of the Montreal Protocol project for the replacing of CFCs in energy inefficient chillers whose refrigerant has high ozone depleting potential (ODP) and global warming potential (GWP). The project was atypical for Brazil as it was the first one focused on energy efficiency and using a co-financing mechanism.
4. In addition to these projects, the National Phase-Out Plan (NPP) for Brazil also had some chillers–related activities.

**LESSONS LEARNT AND RECOMMENDATIONS**

1. Flexibility and longer implementation times are needed for co-funded projects to be able to adapt to the market and country realities.
2. A chiller accounts only for part of the electricity consumption of the whole cooling system. Several other factors have influences and all of them need to be addressed when the decision to replace chillers is made. Retro-commissioning is a larger approach that goes beyond energy savings and comfort. Furthermore, it provides clarifications on the reduction of operation and maintenance costs, even helping for the evaluation of investment paybacks
3. The Kigali amendment to the Montreal Protocol has introduced a new factor that would delay the replacement of HCFC and of HFC chillers because it is not clear yet what substances to select. New low-GWP HFC refrigerants are not yet available in Article 5 countries or are slowly arriving to these markets.
4. There is, it seems an illegal trade of flammable refrigerants. These are introduced in Brazil as hydrocarbons without declaring it as refrigerants and then are commercialized without an ASHRAE number and with no warning about the risk of flammability. Neighboring countries need to discuss and take measures against this issue. Ammonia and HC are limited to the industrial applications. Problems with these substances are related to safety issues, lack of knowledge and adequate training of the work force and therefore intensive training is recommended.
5. Retrofit of chillers led to a decreasing in energy efficiency and therefore such practice has been abandoned in Brazil. The opinion of this consultant is that it may be that retrofits were done by inexpert technicians and/or wrong assumptions were made in relation to energy efficiency and on how energy gains were measured. This issue needs to be addressed in view of future retrofits.
6. Chillers life expectation is estimated at about 35 years on the Brazilian market. Therefore, any policy related to chillers must be carefully evaluated because of its long-term impact.
7. There is no more CFC demand in the country so implementing its destruction is of upmost importance and needs to be accelerated.
8. Chillers sales have decreased dramatically during previous years. Most of the new buildings opted for mini-splits or multi-split, which are substantially cheaper compared to a comfort system based on chillers. Some new buildings did not even install the air-conditioning equipment and only left the piping ready so the new owner assumes the first cost.
9. In an MLF project, collecting and disposing of refrigerant, and an exhaustive investigation about leakage rates of the systems, should be part of the recommendations for the retro‑commissioning. These issues did not seem sufficiently addressed by the project.
10. Recycling centres are available in Brazil, but the lack of widespread recycling is an issue. The benefits of recovery/recycling need to be emphasized.
11. Three seminars were held in Rio de Janeiro, Fortaleza and São Paulo, two training courses in Brasília and São Paulo. The material they developed is on the NOU website, but because of the country size it seems profitable to continue with this campaign if funds are available. A train the trainers program would be useful.
12. Results of activities were disseminated at the national and international events on refrigeration and air-conditioning held in Brazil, but if funds are made available, a regional meeting with the other NOUs would be very profitable in order to show results of the retro-commissioning processes.
13. Although the building managers stated that they were aware of ODS regulations and building codes, the project showed them the whole picture on energy savings for their systems. As explained by the manager of the two private buildings their view on energy savings and comfort is quite different from the standard. Lack of awareness can be an important issue and many owners do not evaluate the possibility of replacing chillers until these break down.
14. For the replaced chillers using funds from the CFC National Phase-Out Plan, replacement did not resulted in a significant gain of energy efficiency, discomfort was relevant and a complete retrofit of the entire system needs to be done. Retro-commissioning studies indicates that energy savings of up to 50 per cent could be possible. In many cases it was detected that the original chillers were oversized and the original design of system was inefficient (i.e., lack of automatization among other issues), which is a common practice at least in A5 countries.
15. There is a difference, concerning maintenance, between private and public sectors. In private sector they have a contract with the provider and can fire and hire easily. In the public sector they have to go through a bidding process, it is more complicated and it takes longer time. The government must always choose the lowest price offer, which does not guarantee service quality. The contract usually does not include the provision of parts.
16. In towns located far from the main cities, it is difficult to find skilled staff. It is important to take local specificities into account, as 20 per cent of the Brazilian population is illiterate, which is an important barrier for efficient training, therefore creative methods should be designed to implement training.
17. In the public sector, legislation and bureaucracy are the main barriers to access funds. Therefore, changes in such protocols are recommended.
18. In the private sector, economic instability, lack of finance, insufficient warranty and high interest rates lead to the postponement of capital-intensive projects. When the owner was able to afford financing chillers replacement and other modification of the entire system were performed and benefits were soon demonstrated. Rent can be raised and the servicing’s monthly expenses may decrease if buildings are more energy efficient, which provides sustainability and is of interest to building owners.

Subsidies on electricity had a dampening effect on energy efficiency investments

1. Financing from chillers providers is not available. Chillers manufacturers are very interested in selling their products but they not always use energy efficiency as a selling argument, as many know that customers are still emphasizing first on cost. Therefore, a deeper involvement from manufacturers is needed in order to promote energy efficient goods.
2. There is a good set of legislation concerning energy consumption for the new buildings and for split-air-conditioning installation and other issues concerning refrigerants and systems. Associations like ABRAVA have an import advisory role on legislation and are the main source of data. It is a positive issue that needs to be maintained and emphasized.
3. Finally, related to the difficulties to get relevant information from the Progress Reports issued by the implementing agencies, it seems recommendable to use a friendlier format for such reports, which provides clear assessment of progress and anticipated outcomes.

**Changes in project design and implementation**

1. The GEF project went through delays in implementations and the whole framework, including the demonstration project had to be re-negotiated and changed. Delays took place because the main players had different timeframes and approaches to implementation. Institutional factors had a role as well. It appeared that the Brazilian governmental coordination committee was reluctant to take part in project implementation and eventually changed its profile, becoming a Consultative Committee, with no executive responsibility. Finally, following negotiations with the GEF and the IDB, the project UNDP/BRA/09/G71 was approved and seven years after the initial approval, the demonstration project (BRA/12/G77) started implementation in 2012. The renegotiated project has five outcomes (see Annex V).
2. During 2013, outcome 1 of the project “Inventory of CFCs and HCFCs chillers” was performed by a local consultant and member of the Brazilian Association of Refrigeration, Air‑conditioning, Ventilation and Heating (ABRAVA). The inventory showed that the quantity of CFC chillers still in use was very small.
3. In addition, the same year, the monitoring of the replacement of chillers of the Ministry of Finance in Brasilia took place with funds from the National CFC Phase-Out Plan. An analysis of the energy consumption before and after replacement was conducted and pointed out that the replacement of chillers contributed only slightly to the reduction of the energy consumption. It concluded, however, that the results could be maximized by retro-commissioning and revealed that the problems of energy efficiency are associated to the entire refrigeration system and not only to the chiller replacement.
4. During 2014 a mid-term audit of UNDP’s project BRA/09/G31 was carried out. This audit also recommended a revision due to several wrong assumptions and the relevant change in the amount of CFCs chillers still active.
5. The findings of the inventory and of the mid-term audit pointed out that it would be more effective to first undertake a retro-commissioning process in private and public buildings. This would complement activities implemented by the other components of the GEF’s Transformation Market Project. The design of the demonstration project was therefore modified.
6. The “Result 5” of the demonstration project which referred to replacement projects was eliminated as the inventory had shown that the number of CFC chillers was very small to make the chiller replacement worth. A “Result 6” was included about four retro-commissioning processes on cooling water systems/chillers.
7. This substantive project revision had as main focus to stimulate interests to improve energy efficiency in the buildings in an integrated way for demonstrating the potential of the energy efficiency in the replacement of chillers. For this purpose, the demonstration project was re-designed with a new purpose and the US $1 million, previously approved by the MLF, was re‑allocated. Expenditures up to 2014 are shown in Annexes VI and VII. While previously the outcome 3 of the larger GEF–funded project, the demonstration project was now implemented as an independent project. Within this new project no chiller replacement and/or conversion would be held with the US $1 million approved by MLF. The outcome (component 6) includes the retro-commissioning as well as technical assistance and advisory for four selected buildings. Chillers replacement, however, would be the building’s owners’ decision and paid by them. The retro-commissioning is a process of commissioning to be held in an existing building. It is not just an energetic diagnosis of the system and it has the main objective of recovering the comfort, air quality and energy efficiency of the whole system, which is not always obtained by replacing the chillers. This process consists in a detailed investigation of the entire system, including original executive design, installation and current conditions of operation and performance. It identifies problems and provides recommendations to optimize the building's cooling water systems. Many problems in the installation are not only due to chillers but also to other components that are part of the installation, such as, *inter alia*, water pumps, cooling towers, control system, ventilation and exhaust system.
8. By the end of the project, professionals of the refrigeration sector and cooling water system will be able to operate in projects that aim at improving energy efficiency in public and private buildings, having learned from technical training events about retro-commissioning in cooling water system projects. The managers of public and private buildings will be qualified for decision-making in projects that engage energy efficiency for air-conditioner and cooling water system.
9. During its 71st meeting, the Executive Committee established the final deadline for the project by 2017. A Project Completion Report (PCR) should be submitted at the first meeting of 2018 (decision 71/10).
10. At the moment of the evaluation, project BRA/12G77, funded by the MLF, is completed. Budget and expenditures are shown in Annex VIII.
11. The GEF project BRA/09/G31 implemented, despite delays, training and awareness actions, creation of energy efficiency projects, evaluation models for the Brazilian banking sector and obtained warranty letters to support six energy efficiency projects. This is a long-term project and needs time to mature. It depends on several market circumstances, one of which is the mentality of potential beneficiaries who not always understand the benefits of energy saving projects and also on economic, financial and legislative issues in the country. (Annex IX).

**Chillers – national context**

1. The inventory undertaken in 2012-2013 by an ABRAVA member revealed that the amount of CFC chillers still in use was very low; only 18 units were using CFCs. For the equipment with CFCs, the inventory estimated, approximately, 9,000 RTs.

### The inventory revealed that the installation of CFC-based equipment occurred mainly before 1995. On 13 December 1995, the National Environment Council (CONAMA) published its Resolution n.13, which prohibits the use of controlled substances included in Annexes A and B of the Montreal Protocol in various types of national and imported equipment, including chillers. In 2000, CONAMA issued Resolution 267, which added some new obligations. A list of the 18 CFC chillers as per the inventory held during 2013 is attached as Annex X.

1. In reference to chillers using HCFC-22, the inventory revealed a significant reduction of production of chillers using HCFC-22 from 2010 onwards. The new chillers used mostly HFC-134a and HFC-410A. Recent information from ABRAVA estimates that chillers with HCFC represent approximately 7 per cent, especially in the industrial sector and in systems with low capacity (air condensed ones). It is worth noting that since the beginning of 2000s, the use of HCFC-based chillers was significantly reduced because of the increase of HFC-based equipment in the market supply. It is estimated that eventually HCFC chillers will be replaced by 2025 and that the lack of HCFC-22 will be the main reason for replacement.
2. According to the NOU, the CFC chillers replacement, both in the public and private sectors, occurred without the assistance of the project. Most of it happened because of the obsolescence of the equipment, lack of spare parts and also the sector’s concern about the lack of CFCs for replenishment in the future.
3. During 1995 and up to 2005 some retrofit of chillers took place, but because of bad results (energy efficiency diminution) such practice had virtually been abandoned. ABRAVA estimates that only one or two per 1,000 units has been retrofitted.
4. It is estimated that these CFC chillers are not in use nowadays and according to the NOU there is no more CFC demand in the country and therefore, those retrofitted are being destroyed.
5. Concerning the chiller manufacturing/importing sector, several manufacturers are established in Brazil but they mostly produce air-cooling systems. The international companies (Midea-Carrier, Johnson Controls-York-Hitachi, Trane and Daikin) capture almost 90 per cent of the market while the other 10 per cent is supplied by domestic companies like Transcalor, Refrisarque and Mecalor. Most big water chillers are imported. Chillers life expectation is estimated to about 35 years on the Brazilian market.
6. Air-conditioning mini-split systems represents 72 per cent of the air-conditioning market while chillers account for only 5 per cent. Due to the economic crisis the chillers’ sales have decreased dramatically during the previous years. Most of the new buildings prefer mini-splits or multi‑split, which are substantially cheaper compared to a chiller-based system.
7. Presently, most of locally manufactured and imported comfort chillers use HFCs. Ammonia and HC-based chillers are limited to the industry process applications. The main issues with these substances application are related to safety issues, lack of knowledge and adequate training of the work force. Absorption chillers are only used in a small number of installations with co-generation for which prices are high and technicians are not prepared to maintain these chillers (i.e., only one absorption chiller imported in 2015). The new low-GWP refrigerants like HFO1234ze have not yet entered the Brazilian market, except for HFO-1234yf, which is being tested in one of the Brazilian car manufacturers.
8. The low-GWP alternatives have been included and well addressed in the technical material prepared during the implementation of project.

**Institutional and legislative issues**

1. As previously reported, project BRA/09/G31 is supported by the GEF and the IDB’s funds. The chillers project BRA/12/G77, funded by the MLF, was one of the components of project BRA/09/G31. Despite the relationship between the two projects, there wasn’t much coordination between them. Project BRA/09/G31 is structured in three axes: capacity building and awareness raising, promotion of energy efficiency in public buildings, and warranty mechanisms to fund energy efficiency projects. It aims to promote best practices for the use of energy resources in buildings.
2. The MMA coordinates the project activities with the assistance of UNDP’s project BRA/12/G77, which was revised, split from the GEF project and began implementation with almost seven years delay from the original date. At that moment a national strategy and extra regulatory provisions were no longer needed since the amount of CFC chillers was irrelevant.
3. In relation to the chiller legislation, the Brazilian Technical Norms Association (ABNT) has several norms related to the refrigeration and air-conditioning sector.
4. CONAMA’s Resolution 13 of December 1995 forbids the production and installation of new CFC equipment, including chillers. CONAMA’s Resolution 267 of September 2000 keeps the ban on the use of controlled substances in Annexes A and B in new national and imported equipment.
5. The MMA/Ibama only controls the import of substances and the Ministry of Industries controls the introduction of new equipment.
6. According to ABRAVA, several resolutions are under implementation in relation to energy consumption for new buildings and to split AC installations.
7. Law 9,991, of July 24 1990, provides for investments in research and energy efficiency by companies in the electric power industry. This law establishes the application of part of the profits (0,5 per cent) of power companies in projects to promote energy efficiency in buildings. Such resources could be used even for replacement of inefficient cooling water systems/chillers, but in order to apply for such funds it is mandatory to prepare a project according to the rules defined in the call of proposals conducted by the Brazilian Electricity Regulatory Agency (ANEEL)
8. Additionally, PROCEL, a government program coordinated by the Ministry of Mines and Energy and implemented by Electrobras, aims at promoting the efficient use of electricity. PROCEL actions contribute to increase the efficiency of goods and services and to the development of habits and knowledge about energy efficient consumption.
9. In the context of project BRA/09/G31, the Labelling Brazilian Programme of INMETRO (National Institute of Metrology, Quality and Technology), PROCEL and the Energy Efficiency Programme of ANEEL were identified as the most effective public programmes to increase energy efficiency initiatives not only in the public sector, but also on the private market. Therefore, BRA/09/G31 developed a series of actions to support building capacity on energy efficiency labeling of buildings, measurement and verification of energy performance and energy management of buildings. To promote the implementation of the energy efficiency label in public buildings, the project provided the first energy efficiency label of a public building to the Ministry of Environment in Brasilia; it supported the process of retrofit of ANEEL headquarters and developed a benchmarking of energy consumption of public administrative buildings including a web-tool for energy management.
10. ABRAVA cooperates with the revision of technical norms and standards. It is the main source of information and statistical data and the NOU works in close cooperation with it. ABRAVA has been established in 1962 and Brazilian and multinational manufacturers, service companies and professionals of the sector are associated to ABRAVA. They have a partnership with the Government and UNDP, which gives them credibility.
11. ABRAVA made a set of recommendations on replacement of refrigerants, and on the legislation to be adopted and also have an advisory role on standards. They are concerned with the handling of flammable refrigerants. According to ABRAVA representatives met by the evaluation mission team, there are blends that are sold on the black market. Several very serious accidents occurred in Brazil due to illegal commerce of flammable refrigerants, which enter Brazil as hydrocarbons without declaring it as refrigerants and then are commercialized without an ASHRAE number and even without any recommendation about its flammable condition. Some of these substances are being offered under diverse designations (i.e., IDEAL 22) and even technical documentation and MSDS are fake. These flammable substances are promoted as being 35 per cent more energy efficient by showing end users only the electricity compressor consumption, but not its performance.
12. The retro-commissioning process followed the norm of the National Environmental Balancing Bureau (NEBB).
13. In Brazil the electricity tariff per KW depends on the availability of electric resources, due to the electricity generation, which is mostly based on hydroelectric resources. A period of draught would lead to tariff increase. Electricity tariff also depend on the each building’s specific use.
14. Concerning the electricity tariffs, some subsidies are provided in Brazil for low-income consumers who consume less than 150Kw/month, allowing them to pay only 30 to 40 per cent of the cost. Finally, an exchange program for domestic refrigerators is in place. Under this programme the old device is sent for recycling and replaced by a more efficient one.

**Implementation issues**

1. When project BRA/12/G77 was revised, split from the GEF project and its implementation began, the Ministry of Environment coordinated the project activities with the assistance of UNDP. (Annex XI).
2. The achievement of outcome 1 “National Inventory of CFC and HCFC liquid chillers” encountered difficulties in estimating the number of chillers, due to the manufacturers and maintenance companies’ reluctances to provide data because of market competition. Eventually, with the help of ABRAVA, an approximate number of chillers in operation was established, including the CFC chillers still in operation.
3. For outcomes 2, 3 and 6, the difficulty consisted in contracting a company with the necessary skills to do the work. Eventually, Somar Engenharia was recruited and the retro-commissioning activities began in 2015 and were carried out.
4. Three seminars were held in Rio de Janeiro, Fortaleza and São Paulo, two training courses in Brasília and São Paulo, which addressed, among other issues:
	* Main types of cooling water systems
	* Energy efficiency concepts related to the refrigeration aspects
	* Energy efficiency and retrofit aspects for the obsolete systems
	* Fluids refrigerants alternatives to CFCs and HCFCs
	* Reduction of recharge of fluids refrigerant in the equipment
	* Methodologies for the elaboration of projects related to the efficient operation of equipment
	* Commissioning and retro-commissioning processes
	* Automatic control and monitoring systems
	* New concepts for projects design for cooling water systems with Chillers
	* Environmental and economic aspects related to the new and obsolete systems
5. The events were attended *inter alia* by specialists and managers of public and private buildings, industry associations, cooling water system manufacturers, university and academics.
6. The publications elaborated are:
7. A technical manual on cold water system for the engineer and specialists of the sector (three volumes). The manual contemplates concepts, projects, installation, operation, maintenance, optimization, chillers replacement and technical-economic strategies;
8. Practical guide on cooling water systems elaborated specially for the building managers; and
9. Two technical papers published in the ABRAVA magazine (refrigeration sector magazine). All developed technical materials are available for free access on a website[[2]](#footnote-2).
10. The technical materials produced can be used for the national capacity building and as source of technical information for future consultations. They are rich on technical information, lessons learnt and guidelines related to the systems design, installation, operation, maintenance, cost evaluation and energy efficiency of the cooling water systems/chillers.
11. The procedures of retro-commissioning were the same for both public and private buildings. The results of the retro-commissioning processes were disseminated by the technical events. Besides the technical and training events held during the demonstration project, a special attention was taken in order to disseminate the results of activities at the national and international events of the refrigeration and air-conditioning sector held in Brazil; such as:
12. Event & R - Refrigeration Industrial and Commercial, Brazilian Association of Refrigeration (2014, 2015 and 2016),
13. Air-conditioning, Ventilation and Heating Fair (FEBRAVA 2014 and 2016); and
14. Energy Efficiency National Congress – COBEE 2016.
15. As a result of the four retro-commissioning, a technical guide was made available for the refrigeration and air-conditioning sectors covering the technical issues and lessons learnt.
16. The demonstration project was important, as the results obtained from the retro‑commissioning processes will assist both public and private building managers and industry experts to adopt similar strategies. The four case studies underwent different realities of the Brazilian market. The technical work was held on buildings with different characteristics and in different regions. There is a national label for the energy efficiency in new and old buildings (i.e., green buildings originated from the GEF project). The retro-commissioning processes were held considering the green building national label.
17. The retro-commissioning processes took into consideration the energy efficiency norms. It was noted during the evaluation mission that the retro-commissioning studies did not registered the refrigerant leakage rate of each chiller. UNDP issued a Memorandum of Understanding with the administration of each of the public and private buildings in order to be able to undertake the retro‑commissioning processes.
18. Concerning the proper environmental disposal of old equipment and contaminated refrigerant, the country had already established a national system for the recovery, recycling and reclaiming processes for the non-contaminated CFCs and HCFCs, before the approval of the demonstration project.
19. According to Normative Instruction 37 of 29 July 2004 of Ibama (Brazilian Institute of Environment and Renewable Natural Resources), reclaiming centers are obliged to report the amount received and marketed. However, ABRAVA stated that only a 20 per cent of refrigerant is recycled. In the mobile air-conditioning servicing sector, 30 per cent of the companies recycle their refrigerants. Recycling centres are available, but the lack of widespread recycling is a problem.

**Main findings during the visits to the buildings**

1. Four buildings have been visited during the mission. In three of the buildings a retro‑commissioning study has been held as part of the demonstration project (two private buildings located in Sao Paulo and one public building located in Cuiaba), while in the other public building located in Brasilia, chillers have been replaced using funds from the National CFC Phase-Out Plan.
2. The whole system has been inspected in each building and administrators, operating managers and maintenance staff have been interviewed in order to get as much first hand information as possible.

Public buildings

1. The evaluation visited a public building in Brasilia, where chillers and some other devices of the machine room had been replaced using funds from the National CFC Phase-Out Plan. The replacement of the chillers was positive because at that moment CFC-11 was difficult to get and also very expensive. But the replacement of the chillers did not result in a significant gain of energy efficiency and comfort and a complete retrofit of all the system needs to be implemented.
2. The new chillers installed are two Carrier R134a units (one centrifugal and one screw). As of writing this report, one of the new chillers is working properly but the other one has been broken for a year and a half. A spare part is needed to repair this chiller, but due to the lack of available funds and the bureaucracy it cannot be purchased, leading to the building’s critical situation. The mission team was informed that the management is willing to go through a retro-commissioning study process, but the same barriers hinder the process.
3. A third party, which has been contracted through a bidding process, is in charge of maintenance and operation. The government must always choose the lowest price offer, so the service is not always the best. This company only provides maintenance and operation service, but no spare parts. The contract does not include the provision of parts.
4. In this building CFC-11 was recovered and sent to a recycling centre. The project payed for the recovery and transportation of the refrigerant.
5. The second public building visited by the evaluation team is located in Cuiaba (Mato Grosso). The building management was already knowledgeable about the existing policies and regulations related to ODSs, building codes and energy efficiency. They therefore accepted immediately the proposal to enter the retro-commissioning programme. They were aware about their high electricity cost, and 30 per cent of their annual budget is spent on electricity payment out of which 70 per cent is because of the cooling system. The Ministry budget, already scarce, has been reduced by 20 per cent due to the crisis.
6. The system has a capacity of 677 RT, included three Hitachi screw HCFC-22 chillers. Each chiller is comprised of three compressors, and the refrigerant charge per chiller is of 99Kg of HCFC‑22, for a total refrigerant charge for the three chillers of 297Kg. The system has no individual automatic controls at all, it is totally manual with an electricity consumption 1,8 times higher than necessary.
7. The retro-commissioning study recommended a total rebuild of the whole installation in order to solve the gain in energy efficiency and comfort.
8. While the retro-commissioning recommendations are deemed valuable, they estimated a need of funds of RS $6,200,000 (US $2 millions) and the building does not dispose of these funds. The building should recruit a company to draw an executive project to rebuild the cooling system, which costs about RS $200,000 (US $70,000) and cannot be assumed by the Ministry of Finance.
9. Once the executive project is ready, the building may be able to apply for funds from various sources. One source could be electricity companies, who are by law obliged to invest 0,5 per cent of their revenues in facilitation of energy projects.
10. In the end, the cost seems to be the main barrier for this project. While funds may be available from several sources, existing legislation limits their access. The Brazilian law does not allow the Ministry of Environment to use its own savings for such projects. Finance offered by chiller providers is not available. Hampered by the lack of funds, the building tries, however to implement some of the retro-commissioning recommendations (i.e., they have already implemented some automatic controls for the system and some building walls have been isolated).
11. Out of three chillers, only two are working and the Management uses the third one, which is broken, to obtain the necessary spare parts that are unavailable on the market because of the age of the chillers.
12. As they have no funds to replace the chillers they have been exploring the possibility to retrofit the old chillers, which is not at all recommendable. They have contacted Hitachi who recommended to replace the chillers.
13. A third company, which has been contracted through a bidding process, is in charge of the maintenance and operation of the system.
14. The leakage rate of these chillers was not investigated during the retro-commissioning study, but the maintenance company informed that leakages of around 5 per cent year are monitored. One time, one of the chillers suffered a catastrophic leakage losing the entire charge of 99 Kg.

Private buildings

1. The evaluation team visited two private buildings in Sao Paulo, both owned by the Pension Fund of Banco do Brasil and rented to various companies.
2. As mentioned earlier, at the time of the mission, the electricity tariff per KW depended on the availability of electricity resources. Rent and maintenance costs also depend on electricity price and therefore both building owners and companies, which rent space in the building, are interested in maintaining a high-energy efficiency. Average electricity prices have been falling since 2006. This trend was accentuated in 2013 by mandated reductions in electricity prices, which averaged about 20 per cent. This factor had a dampening effect on energy efficiency investments. However, the increase of electricity prices due to the high level of use of thermal generation plants, which have high costs, are introducing an incentive for energy saving projects.
3. Previous to the retro-commissioning programme proposal, the owners were very interested in environmental issues. The retro-commissioning study began in 2015. It made a series of recommendations together with an estimation of costs for implementing them.
4. In one of the buildings the original system had a capacity of 1130 RT, included two HCFC‑22 chillers with 400 RT each, plus ice thermo-accumulator. Each Johnson Controls chillers refrigerant charge was 560Kg of HCFC-22. Then the ice thermo-accumulator was eliminated and a third R134a chiller was added.
5. The owner of the building was aware about electricity consumption of the whole system and also about comfort issues and considered as very profitable to introduce the retro-commissioning recommendations. The pension fund was able to afford the financial cost.
6. Therefore, the retro-commissioning recommendations started being implemented starting with the preparation of an executive project. Two HCFC-22 chillers were replaced by two new R134a chillers during 2016, among several other recommended changes. The building spent an estimated RS $2,890,000 (US $876,000) on the retro-commissioning changes, including the replacement of the two chillers. An automatic system to register the cooling load consume of each floor has been installed in order to charge each renter for the real consumption. Each tenant can monitor the consumption by floor, through the Internet. Since the installation no leaks have occurred.
7. The HCFC-22 from the old chillers has been recovered by Johnson controls, but the building owner does not know what was the final destination of the refrigerant. The building is a LEED certified one so it is audited periodically.
8. The provider of the chillers performs the maintenance. The maintenance cost when performed by manufacturer is higher but more efficient and, in addition, the building owner is very demanding about service quality. One refrigeration technician is present for the daily operation of the chillers and is employed as part of owner maintenance staff.
9. The leakage rate of one of the old HCFC-22 chillers was 10 per cent per year but it suffered one catastrophic leakage (the whole charge). The other HCFC-22 chiller had a leakage rate of no more than 1 or 2 per cent year. This data seems not to be well investigated during the retro-commissioning.
10. The chillers have been replaced and 80 per cent of the retro-commissioning recommendations have already been implemented. Gains in energy efficiency are estimated in around 42 per cent once the whole process is ended.
11. In the second private building visited by the evaluation team the original system had a capacity of 1286 RT, included six screw HCFC-22 chillers located on the terrace and on the ground floor (three chillers each). Each chiller is comprised of three compressors and a total refrigerant charge per chiller of 179Kg of HCFC-22.
12. One of the chillers was retrofitted with a drop-in blend but results were bad with an impressive diminishing of the cooling capacity and energy efficiency.
13. The leakage rate of these chillers was not investigated during the retro-commissioning study but the building manager estimated leakages should be high because of the previous poor maintenance of the building. The replacement of the six chillers was recommended. The original design of the whole system is considered problematic with no automatic controls. Therefore, the whole system should be remodeled to gain in energy efficiency and comfort. It was recommended to install two chillers in each of the two floors. It is estimated a gain of approximately 50 per cent in energy efficiency if all the retro-commissioning recommendations are put in place. The total cost for all recommended modifications including chillers replacement is estimated to be around RS $3,600,000 (US $1,091,000).
14. The implementation of the retro-commissioning recommendations were delayed because of the lack of action of the previous building administrator. Now, with a new administrator, the process will begin and plans are being prepared for the complete modification of the system (including chillers replacement), which it is estimated to be completed during the next two or three years.
15. The maintenance provider has been changed and the system maintenance is now provided by two service companies and an independent engineer. In addition, the building has a permanent maintenance staff of two mechanical specialists, three plumbers, three electricians and two supervisors.
16. The operating managers of the four buildings participated in seminars organized with funds of the demonstration projects, which in their opinion were a very positive experience.

**Funds related issues**

1. The original project design with co-funding from the GEF and the IDB went through tremendous delays because of various criteria, schedules, and lack of involvement of some of the actors. The funding mechanism of the two projects is quite different. The main objectives also varied even if there are some mutual areas of interest.
2. In addition, the Brazilian market was not mature enough to replace chillers with the support of financial warranties based on the reduction in energy consumption.
3. Brazilian ESCOS (Energy saving companies) were not developed enough and did not have sufficient capital to finance the replacement of chillers. Their core business is to offer services to the end users.

**Legislation and bureaucracy barriers to access funds**

1. In private buildings, chillers replacements were delayed because building administrators had no clear view of potential benefits (especially economic ones) to be obtained and because just replacing chillers had not resulted in significant energy gains.
2. A simple replacement of chillers in a cooling water system does not provide the energy saving and gains in terms of comfort expected. For relevant energy savings, there is a need to have funds for the whole process in order to perform all the reworks that the system needs. This was one of the reasons the demonstration project was redesigned. To implement, the retro-commissioning process was considered more useful for both private and public sectors, since it provides all the alternatives, technical, maintenance and operation information needed for decision-making in the private and public sectors. These issues are targeted in project BRA/12/G77 by focusing on the retro‑commissioning studies results.
3. Financial issues were fundamental in achieving results. Brazilian banks were not adequately trained to deal with energy efficiecy projects involving equipment replacement. Other barriers were: the limited borrowing capacity, high interest rates, and the perceived risk due to the political and economic instability.

**ANNEX I**

**TERMS OF REFERENCE FOR THE EVALUATION OF CHILLER PROJECTS WITH CO-FUNDING MODALITIES**

**Background**

1. The desk study on the evaluation of chiller projects carried out in 2012 and submitted to the 68th meeting analyzed the efficacy of the eight demonstration projects with a view to improving understanding of progress made, difficulties still being encountered, various attributes and/or shortcomings of the co-funding mechanisms and project approaches in the implementation of chiller projects.
2. The report concluded that the system of stimuli used to drive replacements has uneven results, it is not working in all countries and where it is working it is not fast enough. It includes a large variety of mechanisms, promotions and incentives which are utilized in the eight demonstration projects. However, initiation of these projects had been slow at the time the desk study was written and therefore progress reporting was limited, postponing the second stage of the evaluation, which includes field visits, until the projects reached a more mature stage of implementation. After consultations with the implementing agencies during the Inter-agency coordination meeting, it was agreed that the organization of the second stage of the evaluation for 2017 was opportune.

**Objective of the evaluation**

1. The objective of the evaluation is to collect and analyze information with the aim of finding an answer to the questions and issues stressed in the desk study, especially those related to the functioning of various financial mechanisms. The evaluation will examine the current demonstration projects and assess whether sufficient incentives are in place to catalyse replacements without the Multilateral Fund’s resources, and the problems to be expected in the private sector chillers replacement as well as in the public sector in countries where funds for chiller replacements are scarce.
2. Based on its findings, the second phase of the evaluation will formulate lessons learned that will contribute to future policy development concerning resource mobilization. The field visits will cover six countries with chiller demonstration projects and will ask the following questions.

# **National chiller context**

1. Does the country have an inventory/database of all CFC chillers remaining in operation? What is the age profile of the chillers not as yet converted or replaced? How many chillers of the total were replaced since the beginning of project implementation to date and how many remain?
2. What is the remaining chiller-based CFC demand in the country? And if there is one, how and when is this demand expected to trail off? How is the remaining demand to be met?
3. The impact of regional projects successes and failures on neighboring 5 countries.

**Institutional and legislative issues**

1. Which institution(s) coordinate(s) the chiller replacement (policies and funding)? Is there a national strategy in place to phase out all CFC chillers? Are the required regulatory provisions to drive the chiller phase-out in place? If not, what is still needed?
2. Were project designs different in approach for the public and private sector chillers? Is the private sector proceeding with replacements without assistance and if so why? Is it a fear of diminishing CFC supply or other concerns?
3. Are all of the stakeholders (including government ministries) engaged in the conversion? Is there a coordination/communication mechanism and, if so, how is it working?
4. If there is a dissemination strategy, how is it planned and how was the management modality working? If it is not working, what are the reasons?
5. What role, if any, did the various demonstration projects play in designing and implementing the chiller phase-out strategies?
6. Were there private/public sector policies and strategies in place? Were there corporate social responsibility programmes in place driving the replacement of chillers? Were there any green initiatives implemented with the projects (i.e., green buildings)?
7. Were energy efficiency standards playing a role in the replacement of CFC chillers?

**Funding-related issues**

1. How was the funding modality selected? What barriers or impediments did it encounter?
2. Has co-funding been mobilized or is it anticipated? What were, or are, the problems associated with donor coordination in the face of different criteria, schedules and priorities? How were they overcome?
3. What agreements are/were needed and concluded (why were they needed, with whom, and what is covered)?
4. Are chillers replacements occurring outside the project (i.e., chiller owners and operators) are undertaking replacements on their own initiative? If so, why?
5. What are the chiller owners’ perceptions/views on the efficacy of the various funding arrangements or mechanisms (e.g., concessional loans, grants, revolving funds)?

**Implementation issues**

1. With ongoing chiller conversions and replacements have there been barriers and impediments resulting in significant delays? If so, what were these and have they been resolved; and how?
2. What are the main reasons for public and private sector chiller operators to delay replacement? To what extent, and how, have they been addressed and overcome?
3. For the chillers that have been replaced to date, what were the actual chiller replacement costs (relative to expectations), and how were these costs met? (Who paid what share?) and what were the alternative technologies used?
4. What was the role (or possible future role) of energy savings in both project design and implementation? Can energy service companies and utilities be used? If not, why? Are energy savings now a sufficient driver to cause replacements?
5. Were there any CFC recovered from the chiller projects? Is there, or will there be, any monitoring of recovered CFCs? Is there a plan in place to deal with the recovered CFCs? (Re-use, disposal or destruction?)

Case study country selection

1. The following countries are proposed to be part of the sample of countries to be visited by the evaluation team:
2. Cuba, to explore project implementation in the public sector where chillers are not a luxury, but a necessity (e.g., institutions, laboratories, hospitals);
3. Brazil and Colombia, as countries that have a fully operational chiller replacement project where there are likely many additional lessons to be learned and where the expectation is that the projects underway will serve as a regional model and catalyze early replacements;
4. Sudan, as part of the strategic demonstration project for accelerated conversion of CFC chillers in African countries where progress in implementation has taken place;
5. Argentina, as a country with access to financial inputs such as commercial grants, institutional grants and carbon finance credits. This would allow a more detailed evaluation of the efficacy of this approach; and
6. Thailand, as an example in the use of savings generated by an increase in energy efficiency.

**Methodology**

1. A team of consultants will be recruited based on their experience and knowledge of the subject matter and of the functioning of the Montreal Protocol and the Multilateral Fund. The team will analyse the existing documents as well as the conclusions and recommendations of the desk study and collect additional information from field visits. Discussions with the Secretariat staff, the NOU and the implementing agencies will be organized as needed.
2. A synthesis report will summarize findings from both desk study and country evaluation reports and will formulate lessons learned and recommendations for consideration by the Executive Committee at the last meeting in 2017.
3. Each consultant will be in charge of elaborating the country evaluation report. The team leader, in cooperation with the other team members will draft the synthesis report. Implementing agencies will be involved in participating in the evaluation mission and in providing comments on the reports.

**ANNEX II**

**LIST OF MEETINGS AND CONTACTS**

|  |  |  |  |
| --- | --- | --- | --- |
| **Date** | **Location** | **Description** | **Contacts** |
| 05-08 | Brasilia | Overview presentations andInterviews  | Everton LuceroMagna LuduviceFrank Edney Gontijo AmorimGabriela LiraTatiana OliveiraAlexandra Albuquerque MacielKasper Koefoed-HansenRose DieguesAna Paula LealCelena SouzaMarina RibeiroMaurício Salomão RodriguesLeonildo Tomaz CletoAlvaro A. F. Silveira Junior |
| 05-09 | Brasilia | Visit to 1 public building beneficiary of CFC phase out plan | Magna LuduviceFrank Edney Gontijo AmorimKasper Koefoed-HansenAna Paula LealMarina RibeiroMaurício Salomão RodriguesLeonildo Tomaz CletoElizeu Nascimento SilvaBreno Barros |
| 05-10 | Cuiaba | Visit to 1 public building –Retro-commissioning | Magna LuduviceFrank Edney Gontijo AmorimKasper Koefoed-HansenAna Paula LealMarina RibeiroMaurício Salomão RodriguesMauro de Brito SousaElizeu Nascimento SilvaMárcia Regina Pedroso CanetteSamuel Wesley Montelores de Carvalho KaiserIsarel Corrêa da Silva |
| 05-11 | Sao Paulo | Visit to 2 private buildings – Retro-commissioning | Magna LuduviceFrank Edney Gontijo AmorimKasper Koefoed-HansenAna Paula LealMarina RibeiroMaurício Salomão RodriguesLeonildo Tomaz CletoRogério de MeloEmerson Melo |
| 05-12 | Sao Paulo | Meeting with ABRAVA and Somar Engenharia | Magna LuduviceFrank Edney Gontijo AmorimKasper Koefoed-HansenAna Paula LealMarina RibeiroMaurício Salomão RodriguesLeonildo Tomaz CletoOswaldo de S. BuenoLuciano MarcatoPaulo Neulaender |

**ANNEX III**

**DEMONSTRATION PROJECT AS APPROVED DURING 47TH MEETING**

|  |  |  |  |
| --- | --- | --- | --- |
| **Country** | **BRAZIL** |  |  |
| Project title | Bilateral/ implementing agency |
| **Demonstration project for integrated management of the centrifugal chiller sub-sector in Brazil, focusing on application of energy-efficient CFC-free technologies for replacement of CFC-based chillers** | **UNDP** |
| **Latest reported consumption data for CFC** |  |
| **A: Article-7 data** as of 16.10.05 (ODP tonnes) | 1870 |
|   |
| **Project duration (months)** once all funding components approved | 36 |
| **Initial amount requested (US $):** | 1,000,000 |
| **Final project cost** | Investment activites considered as part of project cost (US $) | 982,015 |
| Non-investment activites considered as part of project cost (US $) | 187,800 |
| Implementation cost related to counterpart funding (US $) | 82,185 |
| **Total Project Cost (US $)** excl. support cost | **1,252,000** |
| Proposed level of external resources from third parties (US $) | 450,000 |
| Activites not considered as project costs (US $) | 198,000 |
| Support cost related to external resources from third parties (US $) | 17,640 |
| **Adjusted level of external resources from third parties (US $)** | **252,000** |
| **Cost of MLF funded component (US $)** | **1,000,000** |
| **Indicators** | Number of chillers foreseen for conversion/replacement within the project | 12 |
| Proportion of counterpart funding to cost of replaced chillers | 54,5 per cent |
| Number of chillers in the country | 1250 |
| CFC consumption for chillers as share of most recent consumption (2004) | 5,0 per cent |
| Share of third-party external resources in project costs | 20,1 per cent |
| Source and level of third-party external resources (co-funding) | GEF PDF: US $250,000; ESCO: US $200,000 |
| Probability of third-party external resources (co-funding) | GEF: Group IIa; ESCO: Group IV |
| MLF funding per chiller (average) | 65,363 |
| Total project funding per chiller (average) | 81,835 |
| Maximum funding per chiller (5 years, 30 per cent discount rate, average) | 91,418 |
| Legislation enacted and enforced | yes |
| General strategy for phase-out of all chillers in the country | yes |
| Inter-linkage with existing phase-out plan | no |
| Request for revolving fund on a regional basis | no |
| **Brief description of methodology proposed** | Analysis of annual cost, separate for public and pivate users. Calculation of incremental needs, basis financial break-even. Use of demonstration phase to develop programs for full conversion of market. 3-step process: 1) Information campaign regarding benefits and incentives; 2) Time-bound incentive to convert on break-even basis; 3) Offset risk, e.g. risk of insufficient energy savings. Detailed action plans, including exploration of performance contracts, tax incentives etc. during demonstration phase |
| **Requested grant (US $):** | 1,000,000 |
| **Implementing agency support cost (US $):** | 75,000 |
| **Total cost of project to Multilateral Fund (US $):** | 1,075,000 |
| **Project monitoring milestones included (Y/N):** | yes |
| Secretariats recommendation: Approval |
|  |  |  |  |

**ANNEX IV**

**BRA/09/G31 OUTCOMES**

|  |  |
| --- | --- |
| **Outcome** |  **Description** |
| **1** | Enhanced EE investments through CB in EE in private & public buildings |
| **2** | Access to EE services and commercial financing for public sector buildings enhanced with the support and strengthening of existing public initiatives |
| **3** | BRA/12/G77 - DEMONSTRATION PROJECT ON INTEGRATED MANAGEMENT FOR THE CHILLERS SECTOR |
| **4** | Local banks begin to treat energy savings as collateral in their lending evaluation matrix. |
| **5** | Monitoring & Evaluation  |
| **6** | Project Management Support |

**ANNEX V**

**ALLOCATION OF US $1 MILLION MLF AS PER ORIGINAL PROJECT DOCUMENT - DESCRIPTION OF ACTIVITIES AND EXPECTED GOALS.**

| **EXP.****OUTPUTS** | **PLANNED ACTIVIT.***List associated activities*  | **SCHEDULE** | **INSTIT.** **IN CHARGE** | **PLANNED BUDGET** |
| --- | --- | --- | --- | --- |
| Year 1 | Year 2 | Year 3 | Origin of resources (inform donor and source) | Budget descrip.(line/item) | Amount |
| **Outcome 1:** National inventory of CFC- and HCFC-based liquid chillers accomplished |
| Output 1 | Verification Report | 50,000.00 | 0 | 0 | UNDP | MLF |  | 50,000.00 |
| Subtotal - Outcome 1: |  |  |  |  |  |  |  | **50,000.00** |
| **Outcome 2:** Technical and information material for promotion and dissemination of results achieved from the replacement of CFC- and HCFC-based liquid chillers elaborated and distributed. |
| Output 1 | Dissemination material | 40,000.00 | 80,000.00 | 0 | UNDP | MLF |  | 120,000.00 |
| Subtotal - Outcome 2: |  |  |  |  |  |  |  | **120,000.00** |
| **Outcome 3:** Workshops, capacity building and training for specialized professionals and owners interested in the replacement of CFC- and HCFC-based liquid chillers carried out. |
| Output 1 | Workshop | 20,000.00 | 20,000.00 | 0 | UNDP | MLF |  | 40,000.00 |
| Output 2 | Capacity building and Training for Professionals | 20,000.00 | 40,000.00 | 0 | UNDP | MLF |  | 60,000.00 |
| Output 3 | Capacity building and Training for Professionals | 30,000.00 | 30,000.00 | 0 | UNDP | MLF |  | 60,000.00 |
| Output 4 | Training for owners, maintenance staff and operators on maintenance and operation | 0 | 60,000.00 | 0 | UNDP | MLF |  | 60,000.00 |
| Output 5 | Final Seminar on Results | 0 | 0 | 20,000.00 | UNDP | MLF |  | 20,000.00 |
| Subtotal - Outcome 3: |  |  |  |  |  |  |  | **240,000.00** |
| **Outcome 4:** Case studies to demonstrate the EE potential and economic and environmental benefits obtained from the replacement of CFC-based liquid chillers in public buildings carried out. **(1)** |
| Output 1 | Case Study – NPP project | 100,000.00 | 0 | 0 | UNDP | MLF |  | 100,000.00 |
| Subtotal - Outcome 4: |  |  |  |  |  |  |  | **100,000.00** |
| **Outcome 5:** Technical assistance for the elaboration of CFC- and HCFC-based liquid chiller replacement projects aiming to increase EE.  |
| Output 1 | Technical assistance for project preparation | 40,000.00 | 200,000.00 | 200,000.00 | UNDP | MLF |  | 440,000.00 |
| Output 2 | Monitoring of project execution. | 5,000.00 | 22,500.00 | 22,500.00 | UNDP | MLF |  | 50,000.00 |
| Subtotal - Outcome 5: |  |  |  |  |  |  |  | **490,000.00** |
| **TOTAL** |  |  |  |  |  |  |  | **1,000,000.00** |

(1) This outcome was implemented under the National CFC Phase-Out Plan (Project BRA/02/G76), finalized in December 2013, and had the objective of monitoring the projects of the replacement of the Chillers (containing liquid cooler, water pump, pipelines, electrical panels and controlling systems) on the Ministry of Finance, Brasília-DF.

**ANNEX VI**

**EXPENDITURES UP TO 2014 (US $)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Total Budget** | **2013 Executed** | **2014 Executed** | **Total Executed** | **2014 Balance** |
| 1,000,000.00 | 32,234.75 | 0 | 32,234.75 | 967,765.25 |

**ANNEX VII**

**RE-ALLOCATION OF REMAINING OF THE1 MILLION MLF AS PER 2014 REVISION. DESCRIPTION OF ACTIVITIES AND EXPECTED GOALS.**

| **EXPECTED OUTPUTS** | **PLANNED ACTIVITIES***List associated activities*  | **SCHEDULE** | **INSTITUTION IN CHARGE** | **PLANNED BUDGET** |
| --- | --- | --- | --- | --- |
| 2014 | 2015 | 2016 | Origin of resources | Amount (US $) |
| **Outcome 2:** Technical and information material for promotion and dissemination of results achieved from the replacement of CFC- and HCFC-based cooling water system elaborated and distributed. |
| Output 1 | Dissemination material | 80,000.00 | 220,000.00 | 25.000,00 | UNDP | MLF  | 325,000.00 |
| **Subtotal - Outcome 2:** | **80,000.00** | **220,000.00** | **25.000,00** |  |  | **325,000.00** |
| **Outcome 3:** Workshops, capacity building and training for specialized professionals and owners interested in the replacement of CFC and HCFC-based cooling water system carried out. |
| Output 1 | Workshop | 0 | 30,000.00 | 0 | UNDP | MLF  | 30,000.00 |
| Output 2 | Capacity building and Training for Professionals | 0 | 30,000.00 | 0 | UNDP | MLF  | 30,000.00 |
| Output 3 | Capacity building and Training for Professionals | 0 | 0 | 30,000.00 | UNDP | MLF  | 30,000.00 |
| Output 4 | Training for owners, maintenance staff and operators on maintenance and operation | 0 | 0 | 30,000.00 | UNDP | MLF  | 30,000.00 |
| Output 5 | Final Seminar on Results | 0 | 0 | 40,000.00 | UNDP | MLF  | 40,000.00 |
| Subtotal - Outcome 3: |  | 60,000.00 | 100,000.00 |  |  | **160,000.00** |
| **Outcome 6:** Retrocommissioning process of cooling water systems with CFC and HCFC performed. |
| Output 1 | Technical Assistance | 0 | 240,000.00 | 242,765.25 | UNDP | MLF  | 482,765.25 |
| **Subtotal - Outcome 6:** | 0 | 240,000.00 | 242,765.25 |  |  | **482,765.25** |
| **Total** | 80,000.00 | 520,000.00 | 367,765.25 |  |  | **967,765.25** |

## ANNEX VIII

**ACTIVITIES ALREADY COMPLETED AND ITS RELATED BUDGETS AND EXPENDITURES**

|  |  |  |  |
| --- | --- | --- | --- |
| **Result** | **Activities** | **Expenditure by Year (US $)** | **Total (US $)** |
| **2013** | **2014** | **2015** | **2016** | **2017** | **2017 (commited)\*** |
| Inventory | 1 | 18,539.52  | 8,000.38  | 64.24  | 5,703.27  |   |   | **32,307.41**  |
| Public Dissemination | 2 | 13,695.23  |  53.88  |   |  34,346.31  |   |   | **48,095.42**  |
| Retro commissioning, workshops and capacity building. | 3 and 6 |   | 325.43  | 103,402.33  | 586,390.54  | 165,40.17  | 64,077.70  | **919,597.17**  |
| **TOTAL** | **32,234.75**  | **8,379.69**  | **103,466.57**  | **626,440.12**  | **165,401.17**  | **64,077.70**  | **1,000,000**  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| \* committed |  |  |  |  |
| 1. Publication printing (4x3000 copies+editing) + final evaluation

(According item 1.4 Project Audit Arragements from the Substantive Project Revision): US S50,317.94 |
| 1. Travel and mission translation (POs): US $13,759.76
 |
|  |

## ANNEX IX

**GEF ALLOCATED FUNDS FOR BRA/09/G31, EXPENDITURES AND REMAINING FUNDS (US $)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Total Budget**  | Executed2011 | Executed 2012 | Executed 2013 | Executed2014 | Executed2015 (\*) | TotalExecuted | Balance forrevision |
| 3,305,000.00 | 696.95 | 63,367.37 | 188,574.59 | 439,304.46 | 333,014.96 | 1,024,958.33 | 2,280,041.67 |

**Source: CDR 2011, CDR 2012, CDR 2014 and UNDP Atlas System.**

**(\*)Expenditures for 2015 with data obtained from the UNDP/Atlas system on 11/23/2015 considering commitments expected to be paid in the current year**

**ANNEX X**

**LIST OF CFC CHILLERS**.

.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Serial Number** | **Chiller Owner** | **City/State** | **Refrig.** | **Year** |
| 4059 | Nuclep | Itaguaí/RJ | R12 | 01/01/1979 |
| 4108 | Nuclep | Santa Cruz/RJ | R12 | 01/01/1982 |
| 4119 | Cia Cacique | Londrina/PR | R12 | 19/01/1979 |
| 4242 | Sicpa | Santa Cruz/RJ | R12 | 19/09/1980 |
| 4243 | Sicpa | Santa Cruz/RJ | R12 | 01/01/1979 |
| 4349 | Sicpa | Santa Cruz/RJ | R12 | 01/01/1979 |
| 4351 | Rhodia Poliamida | Santo André/SP | R12 | 01/01/1978 |
| 4354 | Cotece S/A | Maracanaú/CE | R12 | 01/01/1984 |
| 4390 | Cotece S/A | Maracanaú/CE | R12 | 01/01/1984 |
| 4391 | Cotece S/A | Maracanaú/CE | R12 | 01/01/1984 |
| 5155 | Textil União | Maracanaú/CE | R12 | 01/01/1985 |
| 5158 | Polo | Pirapora/MG | R12 | 06/07/1987 |
| 5185 | Vicunha IX | Americana/SP | R12 | 15/05/1987 |
| 5238 | DuLoren - JoliMode | Queimados/RJ | R12 | 01/01/1987 |
| 5289 | Rhodia Poliamida | Santo André/SP | R12 | 01/01/1988 |
| 5460 | Cotece S/A | Maracanaú/CE | R12 | 01/01/1990 |
| 5461 | Cotece S/A | Maracanaú/CE | R12 | 01/01/1990 |
| 82009 | Ministério da Fazenda | Fortaleza/CE | R12 | 35 years |

**ANNEX XI**

**ADVANCES IN PROJECT BRA/12/G77**

|  |  |  |
| --- | --- | --- |
|  | Year | Advances |
| Outcome 1: National inventory of CFC and HCFC liquid chillers. | 2013 | The inventory listed an irrelevant number of CFC chillers. The inventory listed approximately 130,000 HCFC chillers (1-700 TRs). Much of the new equipment manufacture is being produced with HFCs to replace old equipment.  |
| Outcome 2: Technical materials on the replacement of CFC and HCFC liquid coolers, demonstrating the energy efficiency potential. | 2016 - 2017 | * Manual on Cold Water Systems:

Volume 1: CONCEPTS ON CHILLERS AND COLD WATER SYSTEMS;Volume 2: APPLICATIONS – DESIGN, INSTALLATION AND OPERATIONVolume 3: TECHNICAL AND ECONOMIC ANALYSIS AND SYSTEM OPTIMIZATION STRATEGIES* Practical Guide on Cold Water Systems;
* Technical article on retro-commissioning;
* Technical article including a case study on the retro‑commissioning process;
* Publication of videos related to courses on cold water systems.
 |
| Outcome 3:Workshops to increase interest in replacing or converting CFC and HCFC liquid chiller refrigerants, demonstrating energy efficiency potential and economic and environmental benefits. | 2016 | Seminar on cold water systems in Rio de Janeiro/RJ;Seminar on cold water systems in Fortaleza/CE;Seminar on cold water systems in São Paulo/SP;Course on cold water systems in Brasília/DF;Course on cold water systems in São Paulo/SP; |
| Outcome 4:Case studies to demonstrate energy efficiency potential and the economic and environmental benefits obtained from replacing CFC liquid chillers in public buildings conducted. | 2012 | Outcome implemented under the National CFC Phase-Out Plan (Project BRA/02/G76), with the goal to follow the project of replacing the Chilled Water Supply System in the Ministry of Finance.An analysis of energy consumption before and after the intervention was performed. |
| Outcome 5:Technical assistance for the preparation of CFC and HCFC liquid chiller replacement projects aiming to increase energy efficiency. | 2014 | Outcome canceled due to the following factors:* Irrelevant number of CFC chillers operating in Brazil;
* Financial mechanism (EEGM) provided with funds from the IDB to support the replacement of CFC and HCFC chillers in public and private buildings. EEGM was in its early stage and faced difficulties for its full operation due to a number of factors such as low level of interest or lack of understanding by beneficiaries, including banks.
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| Outcome 6: Air-conditioning systems retro-commissioning processes with CFC and HCFC liquid chillers carried out. | 2015-2016 | Four retro-commissioning processes carried out: * Edifício Birman XXI, in São Paulo/SP;
* Edifício Centenário Plaza, in São Paulo/SP;
* Building of the Superintendence of the Ministry of Finance, in Cuiabá/MT; and
* Building of the Superintendence of the Ministry of Finance, in Fortaleza/CE.
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1. Annex I of document UNEP/OzL.Pro/ExCom/77/10/Rev.1. [↑](#footnote-ref-1)
2. [www.protocolodemontreal.org.br](http://www.protocolodemontreal.org.br) [↑](#footnote-ref-2)