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# STUDY ON DISPOSAL OF ODS COLLECTED FROM REFRIGERATORS AND AIR CONDITIONERS UNDER THE MEXICAN EFFICIENT LIGHTING AND APPLIANCES PROGRAM

(SUBMITTED BY THE WORLD BANK)

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# Disposal of ODS Collected from Refrigerators and Air Conditioners under the Mexican Efficient Lighting and Appliances Program

**Study Prepared for: General Direction for Air Quality Management Environment and Natural Resources Secretariat (SEMARNAT) Mexico and the World Bank**

**Funded by: the Multilateral Fund for the Implementation of the Montreal Protocol**

**Submitted: March 2012**

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# Foreword

The Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol (MLF) provided US$50,000 in grant funding to the Government of Mexico through the World Bank (one of the four MLF Implementing Agencies) at its 58th Meeting (July 2009) to develop a second component of a pilot ozone depleting substances (ODS) disposal project for Mexico. The first had been approved the preceding meeting in April 2009 under UNIDO for the preparation of a pilot demonstration project to identify sources of unwanted ODS in Mexico, and for their collection, transportation, packaging, storage and final disposal.

The objective of the preparation funding provided to Mexico under the World Bank was to specifically to consider the use of ODS disposal methodologies and criteria put forward by the MLF-financed "Study on Financing the Destruction of Unwanted Ozone-Depleting Substances through the Voluntary Carbon Market," for addressing unwanted chlorofluorocarbons (CFCs) collected from refrigerators and air-conditioners under the Mexico Efficient Lighting and Appliances Project that is financed partly by the International Bank for Reconstruction and Development (IBRD) in the World Bank Group. The premise of the proposal was to eventually facilitate full funding of an ODS disposal project through financing from the voluntary carbon market.

At the 63rd Meeting of the Executive Committee in April 2011, Mexico received US$927,915 in funding under UNIDO to proceed with a demonstration project aimed at collecting, transporting and destroying 112 ODP (ozone depleting potential) tonnes of CFCs from the same Mexico energy efficient appliances program. With the approval, the Committee imposed the condition that "any marketing of greenhouse gas (GHG) emission reductions generated by or associated with the project would be subject to a decision by the Executive Committee."

# LIST OF ABBREVIATIONS

| | |
|---|---|
| AHRI | Air-Conditioning, Heating and Refrigeration Institute |
| CAR | California Climate Action Reserve |
| CFC | Chlorofluorocarbons |
| $CO_2$ eq. | Carbon dioxide equivalent |
| CRTs | Climate Reserve Tonnes |
| CTF | Clean Technology Fund |
| DRE | Destruction and Removal Efficiency |
| ELAP | Efficient Lighting and Appliance Project |
| FIDE | Fideicomiso para el Ahorro de Energía Electrica (FIDE), the Trust for Electric Energy Saving |
| GEF | Global Environment Facility |
| GHG | Greenhouse gas |
| GS | Gold Standard |
| GWP | Global Warming potential |
| HCFCs | Hydrochlorofluorocarbons |
| HWCs | Hazardous waste combustors |
| IBRD | International Bank for Reconstruction and Development |
| IPCC | Intergovernmental Panel on Climate Change |
| Kg | Kilogram |
| MP | Montreal Protocol |
| NaCl | Sodium Chloride |
| NaF | Sodium Fluoride |
| NAFIN | National Financiera |
| NOU | National Ozone Unit |
| ODP | Ozone depleting potential |
| ODS | Ozone depleting substances |
| RAC | Refrigeration and Air conditioning |
| SEMARNAT | Secretariat of Environment, Natural Resources and Fisheries |
| SENER | Ministry of Energy in Mexico |
| SIA | Sistema Integral de Atención |
| SISSAO | SISSAO is an MIS maintained by SEMARNAT |
| TEAP | Technology and Economic Assessment Panel |
| THC | Total Hydrocarbons |
| UNEP | United Nations Environment Programme |
| US EPA | United States Environmental Protection Agency |
| USA | United Stated of America |
| US$ | United States Dollar |
| VCS | Verified Carbon Standard |

# EXECUTIVE SUMMARY

The Montreal Protocol on Substances that deplete the Ozone Layer (MP), a protocol to the Vienna Convention for the Protection of the Ozone Layer has successfully controlled the production and consumption of ozone depleting substances (ODS) across the world. However, the Protocol does not address the issue of ODS banks accumulated in older refrigeration and air conditioning (RAC) equipment or kept in stockpiles. Chlorofluorocarbons (CFCs) form a majority of these ODS banks and thus, their management and destruction is the focus of this report.

CFCs, as well as hydrochlorofluorocarbons (HCFCs), also have very high global warming potential (GWP). Studies conducted by Intergovernmental Panel on Climate Change (IPCC) and the Montreal Protocol's TEAP (IPCC/TEAP 2005) estimate that global ODS banks are equivalent to 21.2 billion tonnes of $CO_2$ eq. Out of these, destruction of 8.8 billion tons of CO2-eq is expected to be economically viable. The studies also estimate that in the business-as-usual-scenario, approximately 6 billion tons CO2-eq. of ODS from reachable banks will escape into the atmosphere by the year 2015. Destruction of these reachable ODS banks can provide dual benefits of allowing for accelerated recovery of the ozone layer on the one hand and avoiding emissions of the equivalent of 6 billion tonnes of $CO_2$ emissions on the other. Therefore, it is important that mechanisms be developed to recover and manage reachable ODS stocks.

The Executive Committee of the Multilateral Fund for the Implementation of Montreal Protocol (MLF) has approved a number of ODS destruction pilot projects, which "*... In addition to protecting the ozone layer, will seek to generate practical data and experience on management and financing modalities, achieve climate benefits, and would explore opportunities to leverage co-financing...*" (TEAP 2009). In this regard, the International Bank for Reconstruction and Development (IBRD) requested preparation funding on behalf of the Government of Mexico to study options for sourcing financing from the voluntary carbon market for the management and safe disposal of CFC recovered from old air conditioners and domestic refrigerators in Mexico which are recovered and collected as part of the larger IBRD-financed Mexican energy efficiency program namely, the Efficient Lighting and Appliance Project (ELAP).

Under the ongoing phase of ELAP, as of March 2011, approximately 700,000 refrigerators and 80,000 air conditioners have been replaced with newer, more energy efficient equipment. In the process of dismantling old appliances collected from consumers, large quantities of ODS are being recovered and stored by the authorized appliance scrapping and recovery centers. The foam recovered from the appliances is sent to landfills without extracting CFC-11 because of the high cost of extraction technology.

The ODS stocks recovered consist of CFC-12 (28.5 metric tonnes (MT)), HCFC-22 (47.4 MT) and small quantities of HFC-134a. Among these recovered substances, CFC-12 cannot be resold as it no buyers can be found (use of virgin CFC-12 has been eliminated in fulfillment of Mexico's MP obligations) and recycled HCFC-22 is costly compared to virgin product which is still legally available on the market. Only HFC-134a can be resold in the market. CFC-12 and HCFC-22 have to consequently be stored in cylinders at the scrapping and recycling centers. This stock is a liability since it has an associated storage cost and there are environmental concerns due to the possibility of leakage into the atmosphere. Therefore, a solution is required so that the current stock as well as the future stream of ODS generated from the ELAP program can be managed in an economically viable manner.

This study focuses on exploring co-financing opportunities for management and disposal of CFCs collected under Mexican ELAP program. Voluntary carbon markets provides an opportunity for monetization of climate co-benefits associated with destruction of high-ODP, high-GWP gases, especially CFCs. Voluntary carbon market standards such as the Verified Carbon Standard (VCS) and the California Climate Action Reserve (CAR) have adopted ODS destruction protocols as valid methodologies for generating carbon credits and are studied intensively under this study from the Mexican project perspective.

This report analyzes options for managing the ODS stocks generated from ELAP project implementation, with an emphasis on securing carbon finance through ODS destruction. Four different options for the management of ODS stocks were considered which include[1]:

1. Maintaining the ODS stock in storage tanks for a period of three years
2. Destroying the ODS stock within Mexico in a cement kiln
3. Destroying the ODS stock within Mexico using plasma-arc technology
4. Destroying the ODS stock in a facility in the United States

The various costs and revenues linked to the possible scenarios were calculated. These are compiled in the table below.

| Scenario | Carbon financing | Cost (US$) | Revenue (US$) | Benefits (US$) |
|---|---|---|---|---|
| **Stocked in Mexico** | Not Applicable | 96,775 | 0 | (96,775) |
| **Destroyed in Mexico using cement kilns** | Through VCS | 233,123 | 102,743 | (130,380) |
| **Destroyed in Mexico using a plasma arc facility** | Through VCS | 435,468 | 102,743 | (332,725) |
| **Destroyed in the US** | Through CAR | 377,460 | 899,001 | 521,541 |

The report finds that destroying ODS in the USA and securing revenue through the CAR 'Article 5 Ozone Depleting Substances Project Protocol' is the ideal scenario as it provides a combination of maximum environmental and economic benefits – taking into account that the analysis of costs and benefits of the four scenarios was quite dependent on the estimate of revenues generated from CAR versus VCS and the various parameters of these standards in the Mexican context).

To implement the project under the CAR Protocol, a project developer will have to be identified. The scrapping and recovery centers, SEMARNAT (Mexico's Environment and Natural Resources Secretariat and seat of the national ozone unit) and project developer would subsequently create an implementation plan to have the ODS stock aggregated, exported to the US from Mexico, tested, and destroyed according to CAR requirements. Project-associated risks and returns will become the defining criteria for a cost and revenue sharing arrangement between the stakeholders. Profits earned from such an activity could then be utilized to improve the ODS extraction rate at the scrapping and recovery centers and also to potentially supplement any investment in associated technologies, such as technology to extract CFC-11 from foam.

[1] Reasoning behind scenarios is explained in detail in Chapter 4

# Chapter 1

# INTRODUCTION

The Montreal Protocol on Substances that Deplete the Ozone Layer (MP), a protocol to the Vienna Convention for the Protection of the Ozone Layer has successfully managed to reduce the production and consumption of ozone depleting substances (ODSs). According to UNEP (2010a), as of 2009, parties to the Montreal Protocol have phased out 98% of the consumption[2] of substances controlled by the Protocol. These controlled substances include chloroflourocarbons (CFCs), hydrochloroflourocarbons (HCFCs), halons, carbon tetrachloride and methyl bromide, among others.

However, the Montreal Protocol only mandates the phase-out of production and consumption of ODS. It does not control ODS that have accumulated in equipment such as in old RAC equipment (as either a refrigerant or blowing agent) or kept as stockpiles. ODS in equipment and stockpiles are commonly referred to as ODS banks (MLF 2008).

According to UNEP TEAP (2010), in 2006, the global ODS bank in the RAC sector alone totaled more than 1,875,000 tonnes of ODS. ODS banks in foams are expected to be much higher. The gases contained in these banks will eventually leak into the atmosphere unless they are recovered and destroyed. The release of such high amounts of ODS into the atmosphere will not only damage the ozone layer but also will contribute to anthropogenic global warming due to the high global warming potential (GWP) of these gases. The ozone depleting potential (ODP) and GWP of key ODS are shown below in Exhibit 1.

| Name of ODS | ODP (Reference: CFC-11 = 1.0) | GWP (100 year time horizon) |
|---|---|---|
| **CFC-11** | 1.0 | 4,750 |
| **CFC-12** | 1.0 | 10,900 |
| **CFC-13** | 1.0 | 14,400 |
| **HCFC-22** | 0.055 | 1,810 |
| **HCFC-123** | 0.02 | 77 |
| **HCFC-141b** | 0.11 | 725 |

**Exhibit 1: ODP and GWP of common ODS (Sources: IPCC 2007 and UNEP 2006)**

There are varying estimates available for the reachable ODS banks. Studies conducted by the IPCC and TEAP (IPCC/TEAP 2005) estimated that global ODS banks are equivalent to 21.2 billion tonnes of $CO_2$-eq. A study undertaken through the Multilateral Fund (2006) estimated that in 2010, the worldwide “reachable” bank of CFCs will be 514,652 metric tonnes (ICF International , 2008). However, recovery and destruction of the global ODS bank is not economically viable. The estimated “reachable banks” are equivalent to approximately 8.8 billion tons of $CO_2$-eq. The studies have estimated that about 6 billion tons $CO_2$-eq. of the ODS from reachable banks will escape into the atmosphere by the year 2015 (IPCC/TEAP 2005). Remaining ODS banks are in less accessible, but more stable sources such as building insulation, and are therefore less prone to rapid leakage.

Destruction of ODS banks can have significant environmental benefits. By avoiding the release of these large quantities of ODS, the recovery of the ozone layer is expected to be accelerated by two years. The impact on global warming is estimated to be equivalent to avoiding 6 billion tonnes of carbon dioxide emissions. In comparison, the estimated total reduction of GHG emissions from the first phase of the Kyoto Protocol is 4.3 billion tonnes $CO_2$-eq (EIA 2009).

[2] Consumption per the Montreal Protocol = (Imports + Production) - Exports.

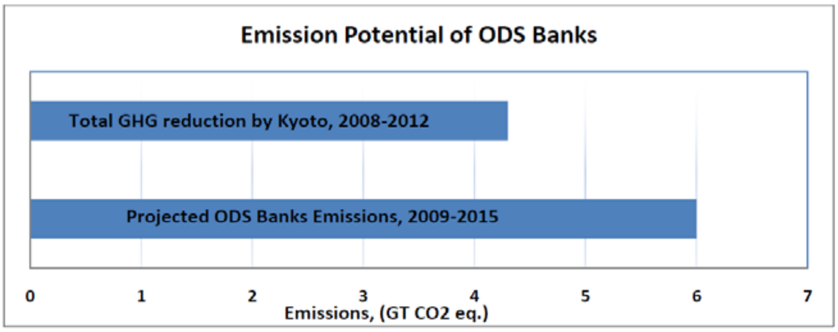


**Exhibit 2: GWP Potential of ODS Banks (Source: EIA 2009)**

In light of these facts, the Parties to the Montreal Protocol adopted Decision XX/7/2 in 2008 (TEAP 2009, pg. 67), which requests the Executive Committee of the Multilateral Fund (ExCom) to:

*"... Consider as a matter of urgency commencing pilot projects that may cover the collection, transport, storage and destruction of ozone-depleting substances... In addition to protecting the ozone layer, these projects will seek to generate practical data and experience on management and financing modalities, achieve climate benefits, and would explore opportunities to leverage co-financing."*

As part of this mandate, the ExCom approved preparation funding for a number of ODS destruction pilot projects in different countries, each with a different demonstration effect and through different MLF implementing agencies according to specific criteria.

One of these proposed projects was aimed at demonstrating the use of ODS destruction methodologies for the safe disposal of ODS recovered from old air conditioners and domestic refrigerators in Mexico, collected as part of an energy efficiency program, namely the Efficient Lighting and Appliance Project (ELAP) which is currently under implementation.

# Chapter 2

# ELAP PROGRAM and ODS COLLECTION IN MEXICO

In response to the energy issues prevalent in the country, the Government of Mexico has promoted a number of programs that help consumers work towards achieving higher energy efficiency. The Efficient Lighting and Appliance Project (ELAP) is one of these programs, wherein support is provided for replacement (and safe disposal) of incandescent electric bulbs, domestic refrigerators and air conditioners. As part of this program, ODS is recovered and stored from disposed refrigeration and air conditioning (RAC) equipment in authorized “storage and recycling” centers of SEMARNAT (Mexico’s Environment and Natural Resources Secretariat and seat of the national ozone unit) in accordance with an environment management plan required by IBRD which is providing financing assistance to ELAP to ensure safe storage of this ODS stock.

## 2.1 Program Background

Mexico follows a subsidy oriented electricity distribution regime. Domestic consumers in the country pay only 58% of the cost of electricity. The average annual electricity subsidy of Mexico for 2005 - 2009 was approximately US$ 15.3 billion (Praz, 2011) which is a huge cost to the national exchequer. In its efforts to reduce the subsidy bill and contain the rising demand for electricity, the Mexican government launched ELAP.

ELAP is designed to replace high energy-consuming appliances, i.e. refrigerators and air conditioners, with substitute appliances that are more energy efficient. The first phase of the project was implemented during 2002-2006 (World Bank 2010a). During this period, 604,335 refrigerators were replaced (Praz, 2011). The second phase of the project was started in March 2009 with a target of replacing 1.7 million pieces of RAC equipment by 2012 (World Bank 2010a). As part of the project, old refrigerators and air conditioners are collected from consumers and sent to scrapping centers for dismantling and recovery of the refrigerants.

The ELAP program is managed by SENER (Ministry of Energy) and operated by the *Fideicomiso para el Ahorro de Energía Electrica* (FIDE) which is the Trust for Electric Energy Saving. FIDE has implementation agreements for the program with SENER and NAFIN (Nacional Financiera or Mexico State Development Bank), and they also receive technical support from the IBRD. The total cost of ELAP project is estimated at US$ 700 million. ELAP utilizes funds from IBRD to meet the cost of subsidies to the consumers, whereas NAFIN (with IBRD support in the form of the Clean Technology Fund (CTF)[3] line of credit) extends credits at favorable interest rates to the consumers to reduce the burden of appliance transition. A related Guarantee Facility, set up with US$ 25 million from the government of Mexico and US$ 5 million from the Global Environment Facility (GEF), protects NAFIN from credits defaults by consumers ( 2010a). ELAP is explained in further detail in Appendix 1.

## 2.2 ELAP Project and ODS Collection

The equipment that is collected from the consumer is delivered to one of the 98 authorized collection and dismantling centers, known as scrapping centers. At the scrapping centers, the received appliances are dismantled and the metal and plastic recovered are sold. The process also results in the extraction of used oil from compressors and refrigerant gases (CFC-12, HCFC-22 and HFC-134a) and foam. CFC-12 and HFC-134a are recovered from refrigerators whereas air conditioners are the main source of HCFC-22. Among these three gases, HFC-134a is sold back in the market whereas CFC-12

[3] CTF: Clean Technology Fund

and HCFC-22 are transferred by the scrapping centers to the SEMARNAT[4] recommended recovery centers.[5] (The MLF funded ODS recovery equipment and training for 14 centers and the same act as SEMARNAT authorized "recovery centers.") In the absence of clear cut guidelines on the treatment of recovered gases, these are stored[6] by the recovery centers under the supervision of SEMARNAT.

The recovered foam is sent to landfills. Although foam contains ODS (CFC-11) as a blowing agent, this ODS is not recovered. The technology that can extract ODS from foam is very costly and currently not available at any of the scrapping or recovery centers.

### 2.2.1 Current CFC-12 stock from ELAP

As of March 2011, the total stock of CFC-12 collected by the scrapping centers was 28.3 tonnes (of which 8.2 tonnes was contaminated and the remainder was pure)[7]. The collected stock of HCFC-22 was 47.4 tonnes of which 385.4 kg was contaminated[8].

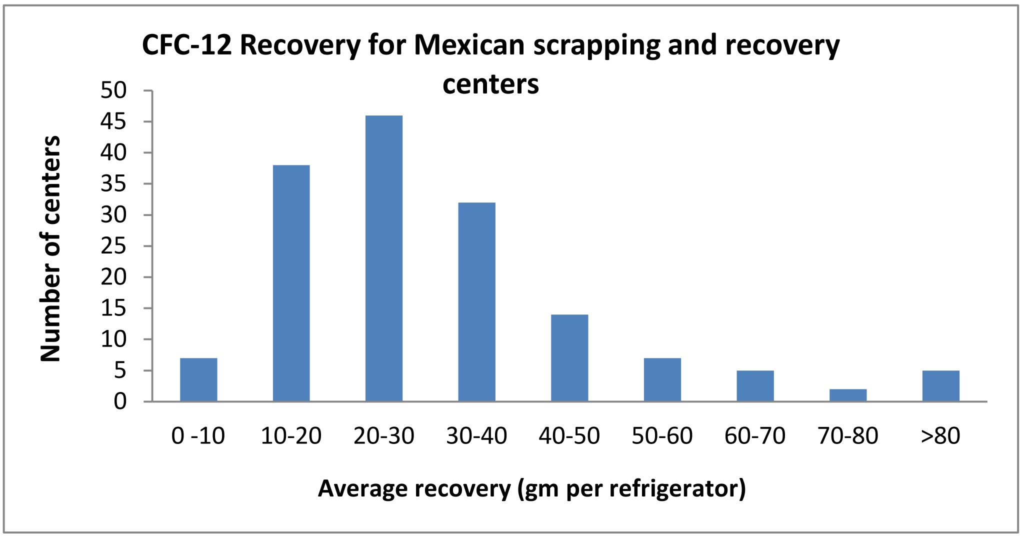


**Exhibit 3: Recovery of CFC-12 across centers in gm/ refrigerator[9]**

The recovery percentage of ODS varies across different scrapping centers and is dependent on the technology used by the center (Exhibit 3). The recovery center visited by the International Consultant (IC) was fully automated and had an ODS recovery rate/level of 86.6 gm per refrigerator (as high as 80%) whereas some scrapping centers with manual extraction of ODS had a recovery rate as low as 2 gm per refrigerator (5%). The variation also is due to the fact that there are currently no incentives for scrapping and recovery centers to try and extract as much ODS as possible from the equipment.
The overall average recovery rate from all the centers was approximately 30.8 grams per refrigerator.[10]

[4] Secretariat of Environment, Natural Resources - *Secretaría de Medio Ambiente y Recursos Naturale* is responsible for regulation of pollutants (including ODS) in Mexico
[5] CFC-12 cannot be sold in the market since it is a controlled substance under the Montreal Protocol and its consumption has been phased out under the protocol. Recycled HCFC-22 cannot be sold in the market since it is costlier than virgin HCFC-22 and also has impurity concerns associated with it.
[6] Safe recovery and storage of the recovered ODS is carried out with the primary focus on maintaining safety and avoiding emissions and wastage.
[7] According to data provided by the National Consultant (NC)
[8] According to data obtained from SISSAO database
[9] Generated from data obtained from the SISSAO database
[10] Derived from SISSAO Database

### 2.2.2 Projections for CFC-12 Collection

As of year 2008, almost 89% of the households in Mexico (with electricity) owned refrigerators (Arroyo et al., 2009). Considering that the average life of a refrigerator in Mexico is 20 years (Arroyo et al., 2009), it can be assumed that most of the refrigerators sold after 1991 would be in operation until now. However, the use of CFC-12 was banned in manufacturing domestic refrigerators in 1997 hence refrigerators sold during the period 1991-1997 can be assumed to be still in operation and containing CFC-12 as refrigerant. From available refrigerator sales figures, it is estimated that 6.3 million refrigerators were sold during 1991-1997.

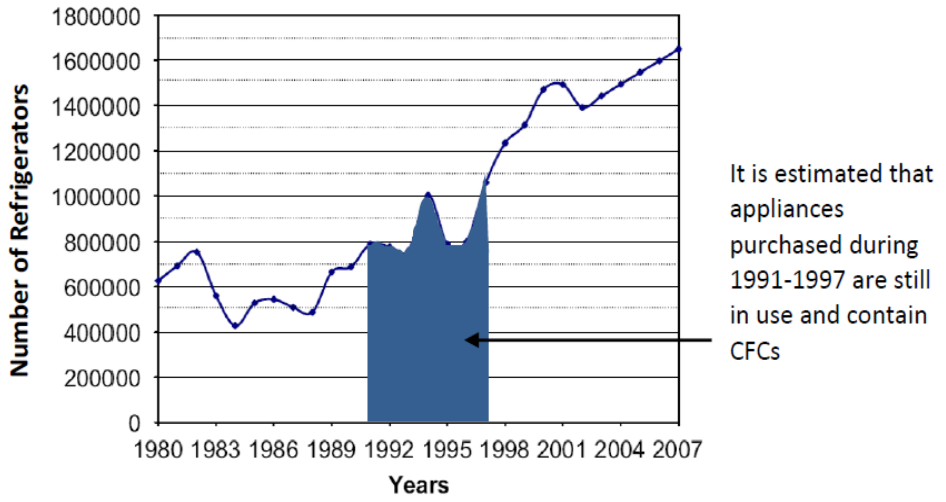


**Exhibit 4: Refrigerators sold in Mexico between 1980 &2007 (Arroyo et al., 2009)**

The current phase of ELAP has a target of replacing 1.7 million RAC units. From the two phases of the appliance replacement project, it was found that 86% of the total appliances replaced were refrigerators (Exhibit 5).

| Type of Equipment | First phase of appliance replacement project (2002-2006) | Second phase of appliance replacement project ( as on Mar 2011)[11] | Total |
|---|---|---|---|
| **Air conditioners** | 129,889 | 79,527 | 209,416 |
| **Refrigerators** | 623,317 | 698,763 | 1,322,080 |

**Exhibit 5: Distribution of RACs collected during appliance replacement programs**

Therefore, it is assumed that approximately 1.45 million refrigerators will be collected by the end of the current phase. Given that the average recovery amount of CFC-12 per refrigerator has been 30.8 gm, it can be estimated that the total CFC-12 collected at the end of the current ELAP phase will be 44.5 tonnes of which pure CFC-12 would be estimated to be 31.60 tonnes (Exhibit 6).

| | |
|---|---|
| Appliances collected under the current phase of appliance replacement project until March 2011 | 698,753 kg |
| Pure CFC-12 recovered from refrigerators replaced until March 2011 | 20,078 kg |
| Contaminated CFC-12 recovered from refrigerators replaced until March 2011 | 8,211 kg |

[11] Derived from the SISSAO database.

| | |
|---|---|
| Projected number of appliances by end of current phase | 1,700,000 |
| Number of refrigerators (assuming 85% of the total appliances) | 1,445,000 |
| Average recovery of CFC-12 per refrigerator | 0.0308 Kg |
| Impurity percentage | 29.0% (based on the purity % of existing stock) |
| Projected amount of pure CFC-12 collected by the end of the current phase of ELAP | =1,445,000*0.0308*0.71=31,554 kg |
| Projected amount of impure CFC-12 collected by the end of the current phase of ELAP | =1,445,000*0.0308*0.29=12,906 kg |

**Exhibit 6: Projections of future recovery of CFC-12 from ELAP**

As there are 6.3 million potential refrigerators from which CFC-12 can be recovered, the amount of CFC-12 recovered can increase significantly in the subsequent phases of the appliance replacement project, ELAP.

## 2.3 ODS collection and Management: Process and Issues

Exhibit 7 displays the movement of refrigerators (containing ODS) from consumers to scrapping centers under the ELAP program. Each process and movement (of refrigerators and ODS) involves a cost. FIDE bears full cost of making the appliance reach the scrapping center by paying the retailer for transportation. FIDE also pays a flat fee of US$ 18[12] for dismantling the appliances at the scrapping centers. The scrapping centers sell the used oil, metal, plastic, and any HFC-134a gas recovered from the dismantled appliances.

The CFC-12 and HCFC-22 collected at the scrapping centers undergo a standard testing and storage process (see Appendix 5 for storage procedures followed by the Mexican scrapping and recovery centers). The major cost incurred by the scrapping center is the cost of cylinders and storage space. The other costs are negligible and are directly or indirectly covered by FIDE. The cost of storage involves using cylinders with cost varying from US$ 8-24 depending on the size of the cylinder. Part of the recovery and storage costs is covered by the fee received from FIDE. The manpower engaged in directly in gas collection is small and the same people are involved in other operations of the center. Gas recovery is estimated to cost 15% of the total demanufacturing cost. Whether the scrapping centers incur costs above the amount provided by FIDE depends on the number of appliances processes a day (the break-even point estimated to be about 30 units a day).

Within six months of extraction, the stock collected at each scrapping center is transferred by FIDE to the nearest SEMARNAT authorized “recovery center.” If the gas has less than 96% purity, the scrapping center must pay approximately US$ 4 per kilo to the recovery centers; if the gas is pure the scrapping center may be paid about US$8 for the gas. All stocks of ODS eventually end up at the 14 recovery centers. Ultimately, the recovery centers are responsible for final storage of the ODS under the program.

[12] Centers receive 250 pesos per piece of appliance, which was US$ 18 at the time of the consultant site visits.

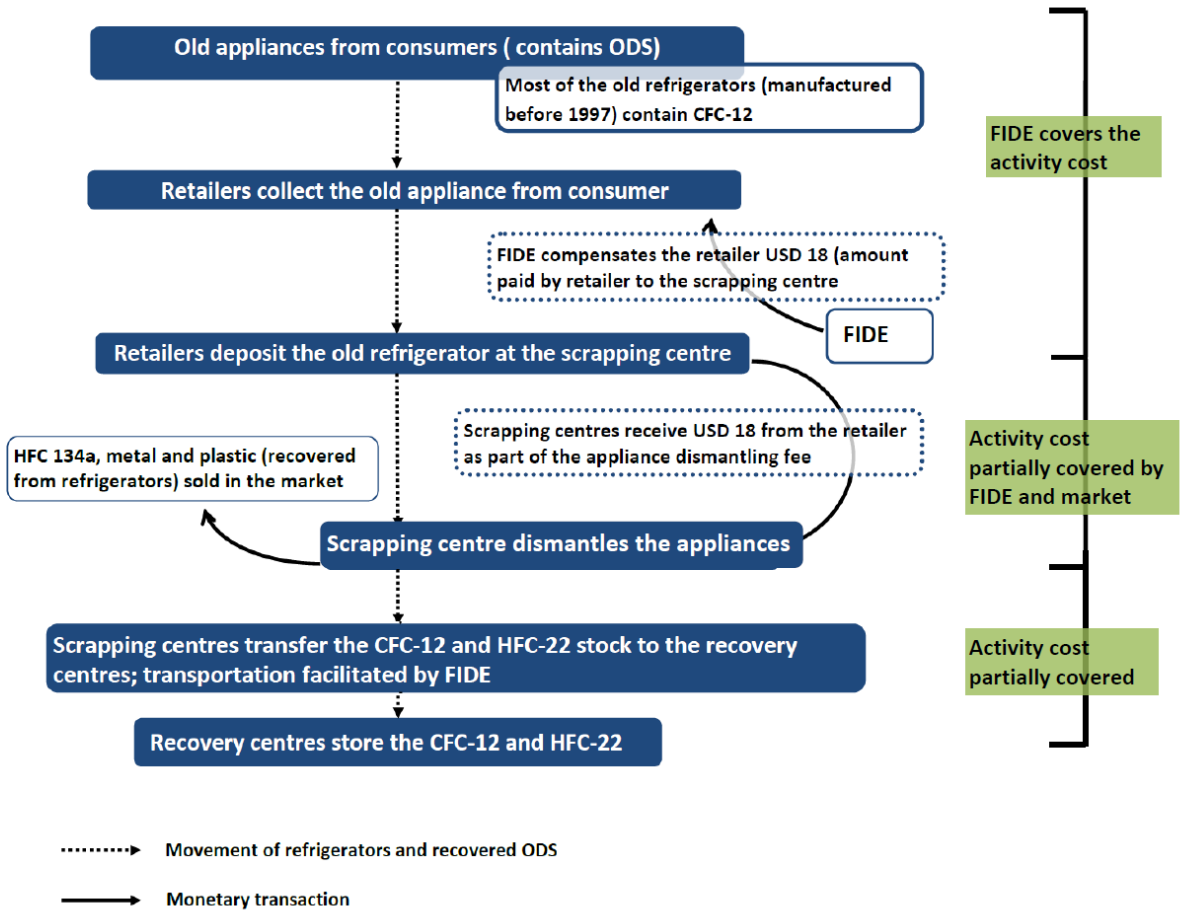


**Exhibit 7: ODS Collection and Financing under the ELAP program**

Therefore, the project results in a negative externality for the scrapping and recovery centers since they have to make continuous investments in the management of ODS stocks by purchasing cylinders. ODS stocks are expected to keep growing as more and more appliances are replaced. This will require incremental investments from the scrapping and recovery centers.

Therefore, to make ODS management operations financially viable, recovery and storage of ODS must be funded by external means, including scenarios whereby:

1. The Mexican Government bears the full ODS management costs incurred by scrapping and recovery centers
2. Multilateral bodies (e.g. the MLF) bear the full ODS management costs incurred by the scrapping and recovery centers
3. Funding is secured through other financial mechanisms (such as carbon finance) to make ODS management up through disposal economically viable

### 2.4.1 ODS destruction and carbon finance

As discussed earlier, ODS gases such as CFC-12 have an extremely high GWP. Therefore, destruction of such gases can be used to generate a large number of carbon credits. Currently, mechanisms governed by the Kyoto Protocol such as the Clean Development Mechanism and Joint Implementation, do not cover these gases and thereby ODS destruction projects are ineligible to earn Certified Emission Reductions (CERs). At the same time, voluntary standards such as VCS (Verified Carbon Standard) and the Climate Action Reserve (CAR) allow for carbon credits to be generated through projects that destroy ODS gases. A comparison of VCS and CAR standards and their impacts on a potential ODS destruction project in Mexico is given in Appendix 2.

Therefore, by utilizing voluntary carbon markets, carbon finance could be obtained for management and destruction of collected ODS and for facilitating further collection of ODS from RAC equipment in the subsequent phases of the appliance replacement project.

# Chapter 3

# MEXICO - POLICY ENVIRONMENT AND ODS DESTRUCTION

Mexico has played an important and pioneering role in the development of many global environment treaties. It was one of the first nations to ratify the Montreal Protocol (MP) and it was the first large-scale petroleum producing nation to ratify the Kyoto Protocol (Pew Center on Global Climate Change). Abiding by its obligations under the Montreal Protocol, Mexico has since modified its national regulatory environment to ensure control and elimination of ODS substances.

## 3.1 Regulations governing ODS production and consumption in Mexico

Following the Vienna Convention for Protection of the Ozone Layer, Mexico signed the MP and officially became a party to the agreement in March 1989. It is also in conformance with the subsequent amendments that were introduced in later years (UNEP 2011). Due to Mexico's participation in the MP, the following policies are applicable to ODS in the country:

a. Licensing and quota system – All ODS are subject to a quota system in Mexico. The Official Quota Memos, as well as the corresponding import permits are issued for a calendar year, and no carry forward within or across corresponding substances is permitted. The import and export of ODS is restricted and any operation has to be authorized by SEMARNAT and the Secretariat of Health and has to be approved by customs (CEC 2011).
b. CFC ban - Consumption of CFCs began to be reduced in 1990 and by 2005, production and consumption of CFCs was stopped. Since 1997 all domestic and commercial refrigeration produced in the country are CFC free.

## 3.2 Mexican Laws and Decrees relevant to ODS Destruction

A number of laws and policies related to emission, land-filling, import-export and destruction of waste materials are present in Mexico. These are summarized as follow:

a. *General Law for Waste Prevention and Integrated Waste Management,* Mexican Official Standard 52 – This law (published in October 2003) establishes the characteristics of wastes, the process of waste identification, waste classification, and also lists classes of hazardous wastes. Some of the ODS including CFC-12 and CFC-11 are classified as hazardous waste and are therefore, covered under the law.

b. *Crimes against the Environment and Environmental Management from Technological and Dangerous Activities*- Under this decree, ODS that has not been banned can be exported presuming proper safety measures are taken. However, export/import of reclaimed and mixed ODS (such as HFC-134a, HCFC-22, etc) is restricted as this is considered as hazardous waste. However, the NOU (SEMARNAT) and the General Directorate of Air Quality Management have the authority to give exemptions to facilitate the export/import of prohibited stocks of ODS.

c. *Official Mexican Standard 40 for Environmental Protection in the Manufacture of Cement and the Maximum Permissible Emissions for Cement Plants (NOM-040-SEMARNAT-2002)* regulates the air emissions from cement plants. Cement kilns are permitted to use alternative fuels, including certain types of hazardous wastes (such as ODS). When using alternative and hazardous waste derived fuels, additional emission limits and monitoring parameters are required including Total Hydrocarbons (THC), heavy metals, and Dioxins and Furans (D&F).

d. *Operational Specifications and Emission Limits of Pollutants*, the Mexican Official Standard 98 (NOM-098-SEMARNAT-2002) – This law applies to all waste incineration facilities except crematorium ovens, manufacturers and steam boilers that use various waste streams as alternate fuels. Its objective is to minimize pollution and to ensure that emission concentrations (especially persistent organic pollutants (POPs)) are kept below prescribed limits during incineration.

   Incineration facilities that are included in TEAP's list of approved destruction technologies for ODS, or which are included but do not meet the required destruction criteria, do not exist in Mexico, hence in-country incineration cannot be used as an option for ODS destruction (as of mid-2011).

e. *Law of Customs Operations* - The purpose of this law is to regulate the import and export of merchandise and the means used for transportation. It also regulates the customs office and all actions that emanate from the entrance or exit of merchandise. The inter-country movement of ODS for destruction or for business is covered under this law. The Tax Administration Service[13] may require that imports and exports be accompanied by customs documents consistent with the international agreements to which Mexico is a signatory.

f. *The Mexican official standard for landfill of municipal solid waste and special waste handling* provides guidelines for municipal and hazardous waste landfills, but does not include ODS.

## 3.3 Mexican Regulatory Scenario and ODS Management

A number of Mexican policies are favorable towards management of ODS. Its destruction in cement kilns can be carried out provided emissions of THCs, dioxins, furans etc. are kept under limits. Pure ODS cannot be imported/exported without permission from SEMARANAT and Customs.

Some policies, however, need modification to improve ODS management. Currently, export of mixed ODS is restricted. Even for the current ODS stock that might be exported to the US for destruction, special permission would be required. Allowing the export of mixed ODS would facilitate easier destruction of such ODS stock. In addition, the standard for land-filling of municipal solid waste and hazardous waste does not consider ODS. Therefore, foam (containing CFC-11) recovered from dismantled RAC equipment continues to be dumped in landfills or open dumps. By regulating this, recovery and subsequent destruction of CFC-11 from foam would be encouraged.

[13] Servicio de Administración Tributary [SAT]

# Chapter 4

# ANALYSIS OF CFC-12 MANAGEMENT SCENARIOS

As part of the Efficient Lighting and Appliances Project, a total of 28.3 tonnes of CFC-12 gas has been collected as of March 2011. There are a number of ways to manage this collected CFC-12 stock. Therefore, it is important to determine the method that will provide the maximum environmental benefits in terms of reduced GHG emission and avoided ozone layer depletion in a financially viable manner.

## 4.1 Scenario Selection

There are two options to manage CFC-12 recovered from demanufactured appliances:

1. Storing the collected CFC-12 in tanks

   Currently, due to absence of clear guidelines on the treatment of recovered ODS, the stocks are safely stored by recovery centers under the supervision of SEMARNAT. In a business-as-usual scenario, this practice will be continued except that the ODS stock collected at the 14 recovery centers would be aggregated in three locations and stored in ISO tanks until the conclusion of the current phase of ELAP.

   The transfer of ODS stock from smaller cylinders to centrally located ISO tanks would make the management of stock easier and would also lead to overall reduced cost of storage and permit regular verification of stock. Also, leakage from an ISO tank would be much less than leakage from thousands of standard gas cylinders.

2. Destroying the CFC-12 in accordance with TEAP standards[14]

   CFC-12 can be destroyed in Mexico or it can be transported to the United States of America for the same. If the destruction is carried out in Mexico, carbon finance can only be availed using the Verified Carbon Standard (VCS). However, if the destruction is carried out in the US, both the VCS and Climate Action Reserve (CAR) standard could be utilized to avail of carbon credits. Furthermore, the cost of destruction depends on the technology used to destroy the CFC-12. There are 10 ODS destruction technologies that conform to TEAP standards (as of mid-2011). However, out of these only two technologies are commercially viable within Mexico – destruction in a cement kiln and destruction in a plasma arc facility (a pilot ODS destruction activity at a cement kiln in Mexico is described in Appendix 3).

Based on the above, four different scenarios are available for CFC-12 in Mexico. These are:

1. Stocking CFC-12 as it is for next three years
2. Destruction of collected CFC-12 in a cement kiln in Mexico
3. Destruction of collected CFC-12 in a Plasma Arc facility in Mexico
4. Destruction of collected CFC-12 in a destruction facility in the US

[14] According to TEAP standards, a destruction technology must have a minimum Destruction and Removal Efficiency (DRE) of 99.99% for ODS from concentrated sources

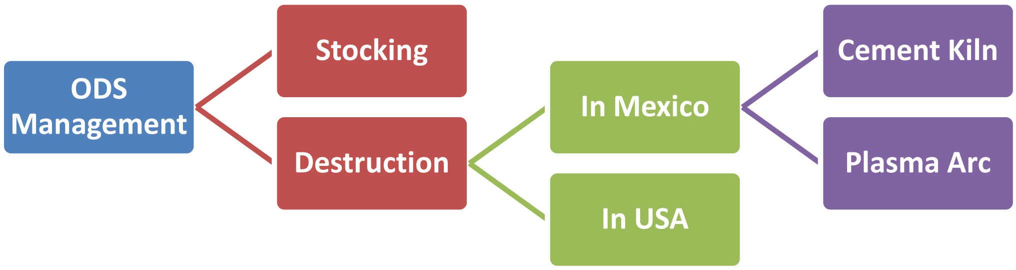


**Exhibit 8: Decision Tool for determining CFC-12 management scenarios**

## 4.2 Methodology for Scenario Analysis

The objective of the analysis is to determine which scenario provides the maximum environmental benefit, while conforming to relevant policies, while being the most economically viable. Therefore, each of the four scenarios is reviewed from three different perspectives: environmental, policy and financial.

### 4.2.1 Methodology for Environmental Analysis

To analyze the environmental impact, Baseline Emissions and Project Emissions are calculated for each scenario. According to the CAR Article 5 ODS Project Protocol, the quantity of emission reductions over a reporting period is calculated using the equations:

Emission Reductions

$$ER = BE - PE \qquad \text{(Equation 1)}$$

Where

ER: Total quantity of GHG Emission Reductions during the reporting period
BE: Total quantity of GHG Baseline Emissions during the reporting period
PE: Total quantity of GHG Project Emissions during the reporting period

Baseline Emissions

$$BE = \sum (Q_i * P_i * GWP_i) \qquad \text{(Equation 2)}$$

Where,

BE: Total quantity of baseline emissions ($tCO_2$)
Q: Total quantity of ODS (MT)
P: Purity Rate of ODS
GWP: Global Warming Potential of the ODS

According to the data reported by SEMARNAT, the following quantities of gases have been collected from the corresponding number of refrigerators as of March 2011:

| Fridges recovered (Units) | Pure CFC-12 (Tonnes) | Contaminated CFC-12 (Tonnes) | Total (Tonnes) | CFC-12 recovery per Refrigerator(gm/unit) |
|---|---|---|---|---|
| **916,247** | 20.078 | 8.211 | 28.289 | 30.88 |

The stock of CFC-12 with 97% purity is considered 'pure,' and anything below 97% is considered contaminated. According to the recommendations made by the National Consultant, contaminated ODS is assumed to have a conservative value of purity of 50%. Therefore:

BE = Avoided Emissions from Pure CFC-12 (97 % purity) +
Avoided Emissions from Contaminated Stock (50 % purity[15])

Project Emissions:

In the case of the destruction of CFC-12, project emissions are equal to the sum of Emissions due to ODS transportation and Emissions due to CFC-12 destruction. The CAR Protocol has given the option to use a default emission factor to calculate the emissions from these sources, as these emissions are very low. This emission factor, which is an aggregate of both the transportation and destruction emissions, is 7.5 tonnes of $CO_2$ emitted per ton of any CFC-12 stock, transported and destroyed.

Therefore:

$PE= Q * P * EF_{td}$ (Equation 3)

Where,

PE: Total quantity of project emissions ($tCO_2$)
Q: Total quantity of CFC-12 (MT)
P: Purity Rate of CFC-12
$EF_{td}$: Default Emission Factor for transportation and destruction of CFC-12

### 4.2.2 Methodology for Policy Analysis

In the Policy Analysis, the scenarios are evaluated for being in accordance with the relevant policies that govern the respective scenario.

### 4.2.2 Methodology for Financial Analysis

In the Financial Analysis, the costs and revenues associated with each scenario are estimated. Mainly, the costs include the cost of transportation of CFC-12, storage of CFC-12, purchase/lease of ISO tanks and cost of destruction process. Revenues are estimated by multiplying the number of carbon credits expected to be generated from the scenario with the price of the carbon credit generated.

Revenue = Expected price of Carbon Credit * amount of emission reductions (Equation 4)

[15] The contaminated ODS ( with purity less than 97% ) contains oil and water, a conservative estímate is used for calculations assuming 50% purity for such stock.

## 4.3 Scenario 1: Stocking CFC-12

Currently, the CFC-12 gas is collected from discarded appliances and stored in tanks. Under ELAP, approximately **44.45 tonnes** of CFC-12 gas is expected to be collected by the conclusion of the current phase of project. Under this scenario, the stocks will be aggregated at three recovery centers and stored in ISO tanks at least until the end of extraction of all ODS stock from this phase.

Considering the fact that ODS leakage from storage cylinders could be as high as 10% per annum (Energy Information Adminstration, 2001), it would not be advisable to store the stocks for long durations.

With CFC-12 stocks found across many Article 5 countries, it is possible that within the next 3 to 5 years, a regulated carbon market may allow issuance of carbon credits for destruction carried out in TEAP-recognized ODS destruction facilities in the host country. Therefore, a wait of 3 to5 years may possibly open an opportunity to carry out destruction of stocked ODS within Mexico and also benefit from carbon revenue under such a market.

### *4.3.1 Policy Analysis*

Under absence of any clear guidelines on managing recovered ODS beyond storage, stocks from FIDE's previous appliance exchange program have been kept stored since the last 5-6 years. Therefore, there is precedent for the activity.

### *4.3.2 Environmental Analysis*

ISO tanks have a very small leakage rate. Therefore, when storing ODS stocks in ISO tanks even for a period of 3 - 5 years, minimal leakage is expected. In case a regulated market develops, the storage of the CFC-12 in the ISO tank in the interim would result in avoidance of CFC-12 emissions.

However, there is always a possibility that ODS gas might be lost to the atmosphere through accidental discharge, intentional discharge or discharge due to "force majeure" conditions. Also, there is a possibility that no such market may develop at all and the gas will eventually leak out from storage. Therefore, from an environmental risk viewpoint, this scenario may not be a favorable option.

### *4.3.3 Financial Analysis*

Keeping CFCs stored will not generate any revenue until a regulated market develops in the future, but there will be an associated storage and maintenance cost. The financial analysis for stocking the CFC-12 is based on the following estimations:

a. Stock is maintained for a long duration (a minimum of three years)
b. Stock is maintained at three recovery centers that are equidistant from scrapping centers
c. ISO tanks are used for safe storage
d. The tanks are initially purchased and may be sold once the gas leaks out

In this scenario, the principal cost components would be:

a. Transportation of CFC-12 to the centrally located facilities
b. Cost of purchasing three 20 tonne ISO tanks (one for each aggregation center)
c. Rental cost of space for parking ISO tanks

<u>Cost of transportation of CFC-12 to centralized locations for consolidation</u>

Based on the geographic distribution of recovery centers, three centrally located centers have been identified for aggregation of CFC-12 stocks viz. Nuevo León, Jalisco and Distrito Federal.

Calculating the cost of transportation based on US$ 0.06 per kg[16] (UNEP 2010), the total cost of consolidation comes out to be US$1079.92. The cost summary is provided in table below.

| Dismantling and Recovery center | Quantity of Gas (Kg)[17] | Expected quantity at the end of ELAP (Kg) | Consolida-tion Point (miles) | Cost of Transportation (US$) for 28.3 MT CFC stock | Cost of transportation (US$) for 44.45 MT CFC stock |
|---|---|---|---|---|---|
| Baja California | 633.56 | 995.47 | 1303.75 | 38.01 | 59.72 |
| Chihuahua | 1,503.09 | 2,361.72 | 736.25 | 90.18 | 141.70 |
| **Distrito Federal** | 4,275.95 | 6,718.56 | 0 | 0 | 0 |
| Guanajuato | 5,287.95 | 8,308.67 | 196.87 | 317.27 | 498.52 |
| Guerrero | 814.95 | 1,280.48 | 226.25 | 48.89 | 76.82 |
| **Jalisco** | 3,701.52 | 5,815.99 | 0 | 0 | 0 |
| **Nuevo León** | 2,312.13 | 3,632.92 | 0 | 0 | 0 |
| Oaxaca | 1,446.15 | 2,272.25 | 306.25 | 86.76 | 136.33 |
| Querétaro | 48.39 | 76.03 | 116.87 | 2.90 | 4.56 |
| Sinaloa | 1,245.60 | 1,957.14 | 430 | 74.7 | 117.42 |
| Sonora | 1,074.40 | 1,688.14 | 935.62 | 64.46 | 101.28 |
| Tabasco | 3,274.41 | 5,144.90 | 476.87 | 196.46 | 308.69 |
| Veracruz | 1,310.21 | 2,058.66 | 215.62 | 78.61 | 123.51 |
| Yucatan | 1,361.34 | 2,139.00 | 825.62 | 81.68 | 128.34 |
| **Grand Total** | **28,289.65** | **44,450.00** | | **1080.00** | **1,697.00** |

The total costs associated with the scenario are summarized as follows:

| S. No. | Cost Component | Unit cost (US$/unit) | Total Cost (US$) |
|---|---|---|---|
| | **Quantity of CFC-12 to be stored is 44.45 tonnes** | | |
| **1** | Transportation of CFC-12 from different centers to the centralized locations for consolidation | 0.06 per kg | 1,697[18] |
| **2** | Cost of purchasing 3 ISO (20 feet, capacity 20 tonnes) tanks[19] | 20,000 | 60,000 |
| **3** | Rental of parking ISO tank for three years | 8 per tank per day | 26,280 |
| | Sub-total | | 87,977 |
| **4** | Contingencies (10% of the total) | | 8,798 |
| | TOTAL | | 96,775 |

* The calculations are for the projected cost of storage for the 44.45 tonnes of stock to be generated by the end of the present phase of the efficient appliance replacement project. The cost of storing the CFC-12 collected as of March 2011 (28.3 tonnes) would be US$ 96,096. Since the total quantity won't exceed 45 tonnes, it is assumed that three ISO tanks will be required for the proposed project activity.

[16] The cost of transportation is assumed to be the same as in a report by UNEP (2010). The International Consultant has sent inquiries for Mexico-specific transportation rates. The response is awaited.
[17] Calculations based on MIS report from SISSAO.
[18] Cost of transportation for 44.45 MT CFC-12 stock.

[19]Hiring and purchasing decision will be based on the facts that the rent of an ISO tank ranges between US$ 30-40 per day and there is an associated space rent of US$ 7-8 (Noakes, 2008). Cost of purchasing an ISO tank is about US$20,000.

### *4.3.4 Conclusion*

The estimated cost of storage of CFC-12 for a period of three years will be US$ 96,775. This also involves investment in ISO tanks which have a resale value. Financially, the investment in this scenario will be justified only when there are indications that the Net Present Value of the revenue from the future CFC-12 destruction will be more than the revenues materialized in Scenarios 2, 3 and 4. However, if the future markets fail to develop, the investment will not generate any benefit since the stored gas will eventually be released into the atmosphere.

## 4.4 Scenario 2: Destruction in a Cement Kiln in Mexico

Destruction of CFCs and HCFCs in cement kilns has been economically and environmentally successful in several locations in the world. A pilot test carried out in Mexico has established that cement kiln-based CFC-12 destruction is possible and one of the options, within some limits explained previously (see Annexure 3 for details).

### *4.4.1 Policy Analysis*

The destruction of ODS in cement kilns by thermal decomposition is a TEAP-recognized process and results in harmless products like salts (NaCl and NaF). A pilot ODS destruction activity was carried out in Mexico by the National Ozone Unit in cooperation with the ECOLTEC cement kiln. Hence there are no regulations that prohibit CFC-12 destruction if the TEAP methodology is followed.

### *4.4.2 Environmental Analysis*

As of March 2011, approximately 20 tonnes of pure CFC-12 and 8 tonnes of contaminated CFC-12 have been recovered. Destruction of this quantity of CFC-12 would result in a savings of **256,857.68 tonnes of carbon dioxide equivalent** emission. The calculation of emission reductions is as follows:

<u>Baseline Emissions</u>

As per Equation 2

BE = Avoided Emissions from Pure CFC-12 (97 % purity) +
Avoided Emissions from Contaminated Stock (50 % purity)

= Q * P * GWP (For Pure CFC-12) + Q * P * GWP (For Impure CFC-12)

= (20.078 * 0.97 * 10900) + (8.211 * 0.5 * 10900)

= 212,284.69 + 44,749.95

= **257,034.64 tCO2e**

<u>Project Emissions</u>

As per Equation 3

PE= Q * P * $EF_{td}$ (For Pure CFC-12) + Q * P * $EF_{td}$ (For Impure CFC-12)

= [(20.078 * 0.97) + (8.211 * 0.5)] * 7.5

= (19.48 + 4.11) * 7.5

= 23. 59 * 7.5

= **176.86 tCO2e**

Emissions Reductions

Therefore the total emission reduction is equal to:

ER = BE - PE

= 257,034.64 – 176.86

= **256,857.78** $tCO_2e$

### *4.4.3 Financial Analysis*

The financial analysis for destroying CFC-12 in a cement kiln in Mexico is based on the following estimations:

a. Stock is directly transported to the destruction facility in ISO tanks
b. ISO tanks are leased-in for the project duration
c. Two ISO-tanks will be used and each of the tanks will be required for 30 days
d. The transportation per kg of CFC-12 is US$ 0.06 per kg (World Bank/ICF International 2010b)
e. Cost of destruction of CFC-12 in the facility is US$ 3.5 per kg[20]

The cost components are provided in table below:

| S. No. | Particular | Unit cost (US$/unit) | Total Cost (US$) |
|---|---|---|---|
| | Quantity of CFC-12 to be destroyed = 28.3 tonnes | | |
| 1 | Transportation of CFC-12 from different centers to the cement kiln using ISO tanks | 0.06 per kg | 1,080[21] |
| 2 | Cost of getting 2 ISO tanks on lease for (20 tonnes)for 30 days | 900 | 1,800 |
| 3 | Costs of destruction of CFC-12 | 3.5 per kg | 99,050 |
| 4 | Human resource – Training and Development | 50,000 | 50,000 |
| 5 | Consultancy fee | 15,000 | 15,000 |
| 6 | Designated Operational Entity charges | 6,470 | 6,470 |
| 7 | Registration and issuance charges ( @ US$ 0.15 per credit) | 38,530 | 38,530 |
| | **Sub-total** | | **211,930** |
| 8 | Contingencies (10% of the total) | | 21,193 |
| | **TOTAL** | | **233,123** |

The calculation of associated revenues is as follows:

[20] Figure provided by the Mexican National Ozone Unit
[21] Transportation cost is independent of distance. It depends only on the quantity of gas to be transported

REVENUE FROM VCS CREDITS

Price of VCS credit from a CFC-12 destruction project = 0.40 US$[22]

Revenue= Price of VCS credit * amount of emissions reduction

= 0.40 * 256,857.78

= 102,743 US$

#### *4.4.4 Conclusion*

The scenario is in-line with all regulations governing ODS management and ODS destruction in Mexico. It is also contributes to the environment by preventing 256,857.68 tonnes of carbon dioxide equivalent emission. However, the costs associated with the project (US$ 233,123) are greater than the expected revenues from sale of VCS credits generated by the project (US$ 102,743), even in a highly conservative scenario. Therefore, from a financial perspective, this scenario cannot be a feasible option.

## 4.5 Scenario 3: Destruction in a Plasma Arc Destruction Facility in Mexico

#### *4.5.1 Policy Analysis*

The destruction of CFC-12 in Plasma Arc destruction facilities is a TEAP-recognized process and results in harmless products like salts (NaCl and NaF). A registered CDM project – *"Quimobásicos HFC Recovery and Decomposition Project"* at Quimobásicos is already utilizing this technology to destroy HFC-23 gas and can therefore be utilized to destroy CFC-12 gas.

#### *4.5.2 Environmental Analysis*

Calculation of emission reductions is the same as in Scenario 2.

#### *4.5.3 Financial Analysis*

The financial analysis for destroying CFC-12 in a plasma arc facility in Mexico is based on the following estimations:

a. Stock is directly transported to the destruction facility in ISO tanks
b. ISO tanks are leased-in for the project duration
c. Two ISO-tanks will be used and each of the tanks will be required for 30 days
d. The transportation per kg of CFC-12 will cost US$ 0.06
e. Cost of destruction of CFC-12 using plasma arc facility (US$ 10 per kg)[23]

The cost components are provided in table below:

[22] As per market experience, recent prices of large VCS projects have dipped to levels as low as US$0.6 per ton. Adding to that, industrial gas destruction projects (which are in large volumes and have significantly less visible co-benefits) are not favored by buyers. Unfortunately, ODS destruction is included as it is considered industrial gases. Therefore, VCS credits generated by such a project are expected to sell at 0.4 US$ per credit

[23] Figure provided by the Mexican National Ozone Unit.

| S No | Particular | Unit cost (US$/Unit) | Cost (US$) |
|---|---|---|---|
| Quantity of CFC-12 to be destroyed = 28.3 tonnes | | | |
| 1 | Transportation of CFC-12 from different centers to the plasma arc facility using ISO tanks | 0.06 per kg | 1,080[24] |
| 2 | Cost of leasing 2 ISO tanks for (20 tonnes)for 30 days | 900 | 1,800 |
| 3 | Costs of destruction of CFC-12 | 10 per kg | 283,000 |
| 4 | Human resource – Training and Development | 50,000 | 50,000 |
| 5 | Consultancy fee | 15,000 | 15,000 |
| 6 | Designated Operational Entity charges | 6,470 | 6,470 |
| 7 | Registration and issuance charges (@ US$ 0.15 per credit) | 38,530 | 38,530 |
| | **Sub-total** | | **395,880** |
| 8 | Contingencies ( 10% of the total) | | 39,588 |
| | **TOTAL** | | **435,468** |

<u>REVENUE FROM VCS CREDITS</u>

= 102,743 US$ (as calculated in Scenario 2)

#### *4.5.4 Conclusion*

The scenario is in-line with all regulations governing ODS management and ODS destruction in Mexico. It also contributes to environmental protection by preventing 256,857.68 tonnes of carbon dioxide equivalent emissions. However, the costs associated with such a project (US$ 435,468) are greater than the expected revenues from sale of VCS credits generated by the project (US$ 102,743), even in a highly conservative scenario. Therefore, from a financial perspective, this scenario cannot be a feasible option.

## 4.6 Scenario 4: Destruction of Collected CFC-12 in Destruction Facility in the USA

#### *4.6.1 Policy analysis*

If the ODS stock is to be destroyed in the US, the destruction facilities must be either an approved Hazardous Waste Combustor (HWC) subject to the US Resource Conservation and Recovery Act (RCRA), CAA, and the National Emissions Standards for Hazardous Air Pollutants (NESHAP) standards, or one that meets or exceeds the TEAP guidelines (CAR 2010). The destruction facilities selected in the analysis of this scenario are US EPA-approved HWC (except for Bowling Green Ohio, which uses a TEAP-approved destruction technology).

Also, given that the ODS stock to be exported from Mexico contains contaminated ODS, special permission is required from the Government of Mexico. This is because export of mixed ODS is banned under the *Crimes against the Environment and Environmental Management from Technological and Dangerous Activities* decree. This special permission can be secured by the National Ozone Unit, the General Directorate of Air Quality Management and all the related offices within the Mexican Government. Importing the stock into the US must be in full compliance with the rules of the US-EPA and US Customs.

[24] Transportation cost is independent of distance and depends only on the quantity of gas to be transported.

#### *4.6.2 Environmental Analysis*

Same as Scenario 2

#### *4.6.3 Financial Analysis*

The financial analysis for destroying CFC-12 in a destruction facility in the USA is based on the following estimations:

a. Stock is aggregated at three selected locations (as in Scenario 1)
b. Stock in transferred in a 20-tonne ISO tank leased from the USA (the current trade agreements do not permit Mexican trucks or ISO tanks to travel in US territory). One ISO tank will be leased from the US and the tank will be required for a total of 180 days (assuming that the activity will be completed in six months). The ISO tank will cost US$ 27 per day (based on the estimates collected by SEMARNAT).
c. Shipping to the facilities can be carried out either via ports in the east coast or west coast
d. Transportation of CFC-12 within Mexico will cost US$ 0.06 per kg
e. Cost of destruction including cost of testing and documentation for CAR will be US$ 7 per kg of gas[25]

For calculation of transportation costs, CFC-12 destruction facilities in the US were identified based on the information available from the US EPA (2011). In order to obtain the most conservative transportation cost, four destruction facilities that were farthest from US ports were selected and the distance of these facilities from the aggregation centers in Mexico was calculated. The results are as follow:

| CFC-12 Destruction Facility in the USA | Distance from Mexican collection Center to a US destruction Facility if approaching from Long Beach, California (km) | Distance from Mexican collection Center to a US destruction Facility if approaching from Port Houston, Houston (km) |
|---|---|---|
| **Bowling Green, Ohio** | **9,578** | **16,836** |
| **Aragonite, Utah** | **10,082** | **14,687** |
| **Port Arthur, Texas** | **9,182** | **15,770** |
| **Sauget, Illinois** | **9,182** | **16,117** |

Correspondingly, the cost of transportation from aggregation centers in Mexico to destruction facilities in the US was calculated using a custom made tool:

| CFC-12 Destruction Facility in the USA | Cost of Transportation - entering US from the East Coast (Long Beach, California) (US$) | Cost of Transportation - entering US from the West Coast ( Port Houston, Houston) (US$) |
|---|---|---|
| **Bowling Green, Ohio** | **11,197** | **18,458** |
| **Aragonite, Utah** | **11,702** | **16,307** |
| **Port Arthur, Texas** | **10,802** | **17,390** |
| **Sauget, Illinois** | **10,802** | **17,736** |

Considering the most conservative estimate, transportation cost from the aggregation centers in Mexico to a destruction facility in the US is taken as US$ 18,458. The following table shows the costs

[25] Figure provided by US based destruction facilities

associated with the destruction of CFC-12 collected in the Efficient Lighting and Appliances Project in an EPA-approved US facility:

| S No | Particular | Unit cost (US$/unit) | Cost (US$) |
|---|---|---|---|
| | **Quantity of CFC-12 to be destroyed = 28.3 tonnes** | | |
| **1** | Transportation of CFC-12 from different centers for aggregation at three locations | | 1,080 |
| **2** | Transportation of CFC-12 from Mexico to destruction facility in the US | | 18,458 |
| **3** | Cost of securing import permit | 0.25 per kg[26] | 7,075 |
| **4** | Cost of leasing one ISO tank (20 tonnes) for 180 days | | 4,932 |
| **5** | Costs of destruction of CFC-12 ( including cost of testing and documentation for CAR) | 7 per kg | 198,100 |
| **6** | Insurance for CFC charge transport in Mexican territory | | 1,000 |
| **7** | Insurance for CFC charge transport in US territory | | 2,500 |
| **8** | Human resource – Training and Development | 50,000 | 50,000 |
| **9** | Consultancy fee | 15,000 | 15,000 |
| **10** | Designated Operational Entity charges | 6,470 | 6,470 |
| **11** | Registration and issuance charges (@ US$ 0.15 per credit) | 38,530 | 38,530 |
| | **Sub-total** | | **343,145** |
| **12** | Contingencies (10% of the total) | | 34,315 |
| | **TOTAL** | | **377,460** |

The calculation of associated revenues is as follows:

REVENUE FROM CAR CREDITS:

Price of CAR credit from CFC-12 destruction project = 3.50 US$[27]

Revenue = Price of CAR credit * amount of emissions reduction
=3.50 * 256,857.58 = 899,001.53 US$

#### *4.6.4 Conclusion*

The scenario is in-line with all regulations governing ODS management and ODS destruction in the US. It is also contributing to the environment by preventing 256,857.68 tonnes of carbon dioxide equivalent emissions. Also, the cost incurred for the proposed project (US$ 377,460) is less than the revenue earned from sales of CAR credits (US$ 899,001) given that a CAR credit is currently worth more than a VCS credit. Therefore, the project scenario is profitable and is the most feasible option from a policy, environmental and social viewpoint.

## 4.7 Conclusion

[26] Figure provided by one US based destruction facilities

[27] According to market prices, CRTs are traded within a price range of 7 – 10 US$ on an average. Therefore, to take the most conservative option, CRT prices are assumed to trade at half the price of lowest priced current CRTs

The analysis of the four CFC-12 management scenarios can be summarized as follows:

| Scenario Number | CFC-12 Management Scenario | Environmental Impact | Accordance with Relevant Policy | Financial Analysis |
|---|---|---|---|---|
| 1 | **Stocking CFC-12** | ✗ | ✓✓ | ✗ |
| 2 | **Destruction of CFC-12 in a Cement Kiln in Mexico** | ✓ | ✓✓ | ✗ |
| 3 | **Destruction of CFC-12 in a Plasma Arc facility in Mexico** | ✓ | ✓✓ | ✗✗ |
| 4 | **Destruction of CFC-12 in a facility in the US** | ✓ | ✓ | ✓✓ |

**Exhibit 9: Analysis of CFC-12 management scenarios**

In terms of the impact on the environment which is strictly from the perspective of ozone and climate protection, Scenario 1 will provide net benefits to the environment only if markets provide an opportunity for profitable CFC-12 destruction by the end of the current phase of ELAP in three years. Otherwise, there shall be no environmental benefit since the CFC-12 stock will continue to be stored in tanks and will eventually leak. Scenarios 2, 3 and 4 avoid the emission of 28.3 tonnes of CFC-12 gas with an equivalent avoidance of 256,858 tonnes of $CO_2$.

In terms of being in accordance with relevant policies, Scenarios 1, 2 and 3 comply with all relevant Mexican laws on ODS management and Mexico's commitments under the Montreal Protocol. Scenario 4 requires additional compliance with ODS import and destruction regulations in the United States of America.

In terms of a cost-benefit analysis, Scenarios 1 will earn revenue if a suitable market develops for ODS destruction otherwise it will suffer a moderate net loss. Scenario 2 suffers from a moderate net loss whereas Scenario 3 suffers from a heavy net loss. Scenario 4, on the other hand, results in profit primarily because of the value of the credit that can be generated and can be used to develop an economically self-sufficient model.

Therefore, based on baseline conditions and excluding any evolution in the criteria of the two standards, destruction of CFC-12 in the United States (and utilizing carbon finance under the CAR standard) is the optimal scenario for providing the maximum environmental (ozone and climate) benefits in a financially viable manner.

# Chapter 5

# ODS DESTRUCTION PROJECT - DESIGN and IMPLEMENTATION PLAN

The proposed project advocates destruction of the current (and future) CFC-12 stocks, generated out of the Efficient Lighting and Appliances Project, in US-based facilities and adhering to the CAR protocol to qualify for carbon financing. This chapter details the proposed project design and implementation plan that is aligned with the specifications mentioned in the CAR Article 5 ODS Project Protocol.

## 5.1 Project Approach

Under ELAP, the scrapping and recovery centers are the owners of the recovered ODS stock.[28] To have the existing ODS stock destroyed while tapping into the carbon market for financing the activity, an equitable and efficient project approach must be devised given that the scrapping and recovery centers are high in number, the ODS stock is distributed across these centers in varying but small amounts, and transaction costs in complying with US and Mexican regulations as well as following the CAR ODS protocol are substantial. The first assumption is that assistance from a project developer to complete the process would be sought rather than individual centers attempting to develop projects or recruit developers separately. From there, two approaches can be envisioned, one whereby SEMARNAT could be engaged as an external advisory entity to facilitate the process of destroying the ODS stock; and two whereby the scrapping and recovery centers would form a collective and function as single entity to make the whole operation more economically viable. How to distribute the resulting revenue both logistically and in equitable terms among the scrapping and recovery centers would be one of the most complex issues to address in either scenario.

### 5.1.1 Destruction Scenario 1: SEMARNAT plays an Advisory Role in the ODS Destruction Process

SEMARNAT (seat of Mexico's NOU) can take the role of overseeing the entire process from aggregation to destruction and facilitate the whole process of ODS destruction within Mexico. This is because the NOU has the most extensive knowledge and information resources regarding ODS stocks as well as ODS technical, management and control issues. Under this scenario, the scrapping and recovery centers would have to agree to work under the guidance and supervision of SEMARNAT for all destruction-linked operations.

The CFC stock owners (scrapping and recycling centers) under the guidance of SEMARNAT would have to identify an entity that can act as a project developer (PD), taking over responsibility of the CFC-12 destruction in the USA.[29] The PD, as defined under CAR is responsible for the aggregation, testing, transportation, verification, destruction of the CFC-12. For selection of a project developer it is proposed that entities which have a strong understanding of the Climate Action Reserve (CAR) ODS destruction methodology, AB 32 and the US voluntary carbon market should be entertained. However, unlike VCS, CAR is a more US-centric protocol and is not associated with many practitioners outside the US. Therefore, it is realistic to invite only companies based in the US for bidding (see Annexure 4 for details of US-based entities that can serve in the role of PD).

Thus, based on CFC-12 ownership and CAR requirements, the following would be the stakeholders for implementation of the CFC-12 destruction project under this proposed scenario:

[28] As communicated to the International Consultant by FIDE and SEMARNAT officials
[29] As part of CAR specifications, Project Developer is required for ODS destruction

1. Scrapping and Recovery Centers (98)
2. SEMARNAT's National Ozone Unit
3. Project developer

### 5.1.1.1 Project Activities

The major project activities, in a scenario whereby scrapping and recovery centers are working under the guidance of SEMARNAT, are depicted in Exhibit 10. The scrapping and recycling centers (CFC stock owners), in consultation with SEMARNAT, will identify a project developer (PD). The PD will facilitate the aggregation of CFC-12 and carry out necessary operations (i.e. adhering to CAR requirements) to deliver the stock to the identified destruction facility. SEMARNAT would extend the required process support to the PD to ensure a reliable operation. Once the CFC-12 stock is destroyed and Climate Reserve Tonnes (CRTs) are issued against the project, the PD will materialize the revenues by selling the CRTs. These revenues would then be shared between various stakeholders.

### 5.1.1.2 Cost and Revenue sharing arrangement

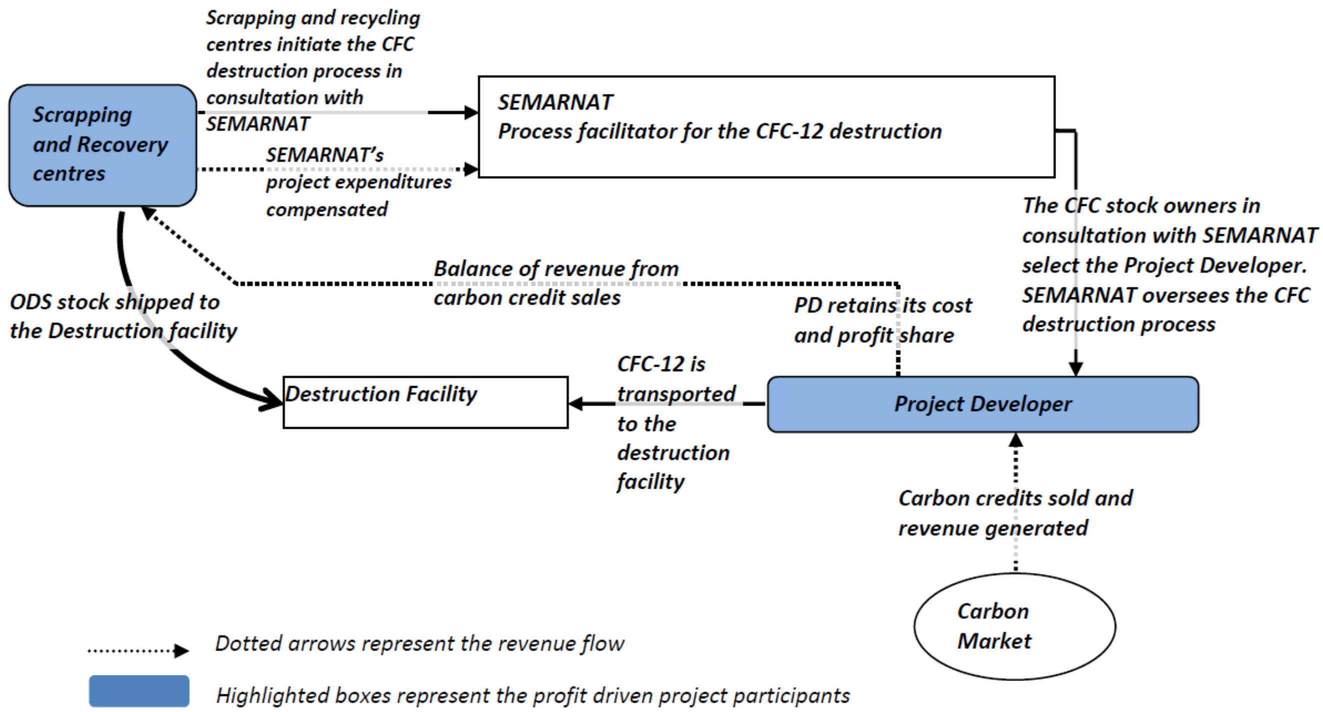


**Exhibit 10: Possible ODS Destruction Project – Process and Revenue Flow Diagram**

The costs involved in processes from CFC-12 aggregation to sales of CRTs would be borne by the PD. SEMARNAT might also incur administrative expenditures which would involve costs of documentation and process facilitation in the whole process. The scrapping and recovery centers would not be required to carry out any additional operations, therefore there would be no additional expenditures for them.

The revenue sharing formula will be based on:

1. The project cost for respective stakeholders
2. The profit sharing agreement between the stakeholders

Once the CRTs are realized and sold, the PD would retain its revenue share and transfer the remaining amount to the participating stakeholders. SEMARNAT would get the revenue share equivalent to its project expenditure and the CFC stock owners would share the remaining amount based on the formula discussed in the following section.

The scrapping and recovery centers can distribute revenue in two proportions in light of two different costs, i.e. cost of extraction of ODS from equipment and cost of storage of extracted ODS.

1. For compensating the cost of extraction of ODS, the respective 98 centers would get the part of the revenue based on their respective share in the total CFC-12 stock (that was destroyed).

2. For compensating the cost of storage of ODS, the 14 recovery centers (which also serve as scrapping centers) would earn additional revenue as compared to the other 84 dedicated scrapping centers, as these 14 centers must mandatorily stock the ODS received from the other 84 centers without additional financial incentive by the Mexican Government.

#### 5.1.1.3 Risk and Revenue Sharing models

The option of destroying CFC-12 stock in the US is based on the environmental and financial benefits of this scenario. The stakeholders would come together to participate in the project since they would be incentivized with an extra revenue stream along with an opportunity to rid themselves of the CFC stocks which become costly to maintain over time. The numbers used in the financial analysis are subject to limitations and uncertainties associated with carbon market projects yet the predicted returns after selling CRTs are critical to the success of the activity and future sustainability.

Despite the merits of the proposed project, the project stakeholders would remain susceptible to the risks associated with the price fluctuations inherent to the carbon markets. The revenue will be always subject to large risks because of the complex and tedious process involved in the measurement of emissions reductions and issuance and sale of CRTs. Prices of CRTs are also subject to market fluctuations which can affect the revenue stream and eventually, the project's operational and financial viability.

Various risk management scenarios can be employed by the project stakeholders in order to contain their risk exposure. These include possible stakeholder constellations as follow:

1. **Entire risk with the Project Developer**:

    a. **ODS Destruction Facility as the Project Developer:** In this case, the ODS destruction facility in the US can act as the project developer as it can easily facilitate transport, import and verification of ODS before destroying it. The entire project risk can consequently be absorbed by the PD. It can purchase the CFC-12 stock directly from the recovery centers at a mutually agreed price and take the entire profit made from sales of CRTs. The centers would be free from risk but their revenue will be fixed, and perhaps lower than otherwise, and will not depend on the price secured by the PD for the CRTs.

    b. **Consultant hired by a collective of scrapping centers to serve as PD:** In this scenario, the centers would form a collective and take on the responsibility of aggregating the stock. Under SEMARNAT's supervision, a consultant may be hired for having the stock destroyed in the US. The consultant can be paid a fixed fee and the centers can earn large revenues if they are able to secure a good price for the CRTs, however, they would be highly exposed to project risks.

2. **Risk shared by multilateral institutions**: A multilateral institution can formulate and execute a contract whereby in case of excess losses, the multilateral institution would cover

part/full losses suffered by the stakeholders. In this scenario, the multilateral institution, in consultation with CFC-12 owners (scrapping and recovery centers), and the PD would define the cost and revenue sharing arrangement between the stakeholders.

3. **Risk shared between scrapping centers and the project developer-** In this scenario, a success fee model may be adopted. The ODS destruction entity would take up the role of the PD and would fix the revenue shared with the scrapping and recovery centers as a percentage of the price at which CRTs are sold. In the case, the risk is shared between the CFC-12 stock owners and the project developer.

### 5.1.2 Destruction Scenario 2: Recovery and Recycling Centers form a Collective to facilitate ODS Destruction

As discussed earlier, in this scenario, the recovery and recycling centers would have to form a collective in order to ensure economic viability of the destruction activity. The collective would have to coordinate with a Project Developer in the US and also carry out all the necessary project steps in Mexico. The collective would have to define a governance mechanism to ensure operational ease and efficiency.

The design and activities in this scenario will not be very different from Scenario 1. The sole difference is that SEMARNAT would be replaced by a service provider/consultant to ensure ease of operations (the need for a service provider will depend on the expertise or limitations of the consortium formed by the recovery and recycling centers).

The project activities, revenue sharing and risk sharing mechanism in this scenario will remain the same as Scenario 1 with the role of SEMARNAT replaced by that of a service provider. The service provider/consultant would be paid for services either with a fixed amount or per the outcome of the activity and quality of services provided.

## 5.2 Utilization of Revenue

As discussed in Chapter 2, the recovery rate of different scrapping centers varies highly. For automated centers, the recovery rate can be as high as 80% whereas for manual centers, the recovery rate can be as low as 0.5%. This is because currently there is no motivation for scrapping and recovery centers to try and extract as much ODS as possible from the equipment. By linking the revenue received from ODS destruction with the quantity of ODS extracted, centers will be motivated to improve their ODS recovery rates. They would also have an incentive to invest in technology and training of staff to further improve ODS recovery rates from the appliances.

Another issue discussed is the recovery of ODS from foam. Currently, foam is sent to a landfill even though it contains CFC-11. Since extraction of ODS from foam requires expensive technology, it is currently not employed by any of the scrapping and recovery centers. Revenue realization from ODS destruction may encourage stakeholders, including SEMARNAT to invest in foam recovery technology for selected recovery centers, and the project and its stakeholders could earn additional revenue from the destruction of extracted CFC-11.

# Chapter 6

# THE CAR ODS PROJECT PROTOCOL AND AN ODS DESTRUCTION PROJECT FOR MEXICO – GAP ANALYSIS

From the analysis of the possible scenarios for ODS destruction, it is evident that the scenario wherein destruction is carried out in the US and CRTs are claimed under CAR, is the ideal one at the time of preparing this report – providing, in combination, the maximum environmental (climate and ozone) and economic benefits. It has been seen that the outcome of the analysis of costs and benefits of the four scenarios was particularly influenced by the estimated revenues generated from the CAR standard versus the VCS and to their respective protocol criteria in the Mexican context. It is important to note that the conclusion is time sensitive and dependent on circumstances that are liable to change. Certain changes in the ODS destruction methodologies (which are namely envisioned under the CAR Article 5 Ozone Depleting Substances Project Protocol in mid-2012) would naturally impact the analysis of the most advantageous scenarios.

The CAR ODS Project Protocol relies heavily on stringent project verification for its credibility. It requires a Monitoring and Operations Plan to be established for all monitoring, operations, and reporting activities associated with ODS destruction projects.

This final chapter outlines the various requirements for implementing the monitoring plan associated with a carbon financed ODS destruction project. Gaps are then identified in terms of the available data and current processes in Mexico and changes and improvements are suggested.

## 6.1 CAR Protocol – Project Monitoring

The monitoring plan of a project is used as a guideline by verification bodies to verify the project. The Monitoring and Operations Plan must address the following concerns related to an ODS destruction project:

### 6.1.1 Data Acquisition and Record Keeping

This plan should detail the process and frequency of data collection at various stages of the project. One of the most important aspects is to collect data at the point of origin for each quantity of ODS. It is essential for the project developer to maintain a detailed acquisition record of all quantities of ODS destroyed by the project.

All data must be generated at the time of collection from the point of origin of the ODS. Documentation at the point of origin of ODS should include the following:

- ✓ Address of point of origin
- ✓ Identification of the system by serial number, if available, or description, location, and function, if serial number is unavailable (for quantities greater than 500 pounds)
- ✓ Serial or ID number of containers used for storage and transport

The project developer must maintain a full record of the US-EPA and/or US Customs import process. The record must include the following:

- ✓ Commercial invoice showing transfer of ownership of the ODS from the owner in the source country to the project developer;
- ✓ Shipping manifests or ocean bills of lading (where appropriate) showing the country of export

- ✓ US Customs import declaration showing the product being imported into the US;
- ✓ For imports of used ODS, a copy of the EPA's non-objection notice that corresponds to the import of the used ODS (this non-objection notice is not required for imports of virgin EPA "Class I Ozone-depleting substances" for destruction); and,
- ✓ Mode of transport, distance travelled prior to arriving at a US port of entry, and net weight of the ODS and containers transported.

**6.1.2 Stakeholder responsibility map**

This map should outline the entire process flow and roles and responsibilities of various stakeholders in the whole process. It is very important to demonstrate the proper custody and ownership of ODS from the point of origin to the destruction prior to the development of project, as no emission reduction credits can be issued under the CAR ODS Protocol if ownership of ODS cannot be established. This highlights the importance of close co-ordination between ODS aggregators, project developers, and destruction facilities. Some of the documents that could be used to demonstrate proper transfer of custody are:

- ✓ Tax ID, or other applicable identifier, of transferor and transferee
- ✓ Bill of lading and date of transfer of custody
- ✓ Serial or ID numbers of all containers containing ODS (received and delivered)
- ✓ Weight of all containers containing ODS (received and delivered)
- ✓ Distance and mode of transportation used to move ODS (truck, rail or air)

One of the most important stakeholders in the entire process is destruction facility as it are supposed to perform a number of important tasks including ODS composition and quantity analysis, which is covered in the next section. Destruction of ODS must occur at a facility that meets all of the guidelines provided in the TEAP Task Force on Destruction Technologies, the "Code of Good Housekeeping," (Dec. XV/9 of the Parties to the MP) and all relevant laws of the US EPA.

**6.1.3 ODS composition and quantity analysis**

ODS destruction credits are given according to emission reductions achieved from ODS destruction and thus, ascertaining the quality and quantity of ODS destroyed is of paramount importance. Thus, prior to destruction, the precise mass and composition of ODS to be destroyed needs to be determined.

- ✓ Mass can be determined by individually measuring the weight of each container of ODS: (1) when it is full prior to destruction; and (2) after it has been emptied and the contents have been fully purged and destroyed. The mass of ODS and any contaminants is equal to the difference between the full and empty weight, as measured.

- ✓ Composition and concentration of ODS and contaminants can be established for each individual container by taking a sample from each container of ODS and having it analyzed for composition and concentration at an Air-Conditioning, Heating and Refrigeration Institute (AHRI) certified laboratory using the AHRI 700-2006 standard, or its successor. As composition analysis is required before destruction, an AHRI certified laboratory in the US can be contracted to perform the composition analysis once the material reaches the destruction facility but before the destruction process.

### 6.1.4 Adherence to Reserve ODS tracking system

In order to ensure the integrity of ODS destruction projects, the Reserve (CAR) maintains an online database of all destruction activities for which CRTs are registered and issued. Entries into this system within the Reserve software must be made by the project developer prior to the beginning of verification activities to confirm that reductions have not been claimed by other parties for the destruction activity in question.

All projects are required to have one or more Certificate(s) of Destruction accounting for all eligible ODS destroyed as part of the project. The following information shall be entered by the project developer into the Reserve software from the Certificate(s) of Destruction issued by the destruction facility, and a copy of the certificate(s) must be provided to the project verifier:

- ✓ Project developer
- ✓ Destruction facility
- ✓ Generator name (party requesting destruction)
- ✓ Certificate of Destruction ID number
- ✓ Starting destruction date
- ✓ Ending destruction date

## 6.2 Gap Analysis

With the knowledge of the current status of elements required for an ODS destruction project and requirements for registering and generating carbon credits under the CAR ODS destruction methodology, a gap analysis which can help improve the systems and process on the ground in Mexico to facilitate the execution of and monitoring of an ODS destruction project in the carbon market is presented below. The following table therefore shows a detailed analysis of the current systems in place by both SEMARNAT and FIDE and whether they are able to meet the requirements of the CAR Protocol:

| CAR REQUIREMENTS | CURRENT SYSTEMS |
|---|---|
| POINT OF ORIGIN OF ODS | |
| Address of point of origin | Point of origin in this project would be the scrapping centers. FIDE has all the documents that prove the legality and the procedures for opening of each and every center for its program and documentation to prove that CFC is collected at these centers |
| Quantities available at each Center | Records in the online databases of SEMARNAT and FIDE, namely SISSAO and CIA respectively |
| The type of ODS –<br>1. Virgin or,<br>2. Collected from end-of-life equipment<br><br>Time Period of ODS Collection | Needed before exporting as well as before Project Listing. Information about the number of equipment disposed and quantity of ODS collected daily is contained in the CIA. As all ODS is collected from disposed equipment, there can be no virgin stock |
| Identification of the system by serial number, if available, or description, location, and function if serial number is unavailable (for quantities greater than 500 pounds) | Available |

| CAR REQUIREMENTS | CURRENT SYSTEMS |
|---|---|
| | |
| Serial or ID number of containers used for storage and transport | Available |
| **IMPORT DOCUMENTATION REQUIREMENTS** | |
| Letter from SEMARNAT stating that there is no production of any virgin CFCs in Mexico | Needed before Project Listing. Can be arranged by the National Ozone Officer |
| Letter from SEMARNAT stating that there is no legal or regulatory issues in the export of the ODS stocks to the US for destruction, and that the stocks are eligible for export under all circumstances | Needed before exporting the stocks as well as before the Project Listing. Can be arranged by the National Ozone Officer |
| Commercial invoice showing transfer of ownership of the ODS from the owner in the source country to the project developer | Document authorizing Project Developer to handle the CFC stock until destruction can be done |
| Shipping manifests or ocean bills of lading (where appropriate) showing the country of export | Needed before Project Listing |
| US Customs import declaration showing the product being imported into the US | Needed before Project Listing |
| For imports of used ODS, copy of EPA non-objection notice (this non-objection notice is not required for imports of virgin CFCs for destruction purposes) | Needed before Project Listing |
| Mode of transport, distance travelled prior to arriving at a US port of entry, and net weight of ODS and containers transported. Copy of CFC ODS import report showing that product has been imported for destruction | To be provided by project developer in consultation with National Ozone Officer |
| CUSTODY AND OWNERSHIP DOCUMENTATION REQUIREMENTS | |
| Names, addresses, and contact information of persons of collection centers and the recycling centers | Documents available with FIDE to prove the legality and the procedures followed for opening each center for its program |
| The types and quantity of each type of ODS to be sent for destruction | Online records in the online databases of SEMARNAT and FIDE, namely SISSAO and SIA; apart from other records which SEMARNAT and FIDE maintain |
| Purity test results of the ODS | The existing stocks have already been tested using an electronic analyzer that is available at all collection centers; Once aggregation is done in an ISO tank, then the ODS would have to be tested again for the final purity. According to the National Ozone Officer, testing |

| CAR REQUIREMENTS | CURRENT SYSTEMS |
|---|---|
| | equipment such as gas chromatograph is available in Mexican universities and is also available with private refrigerant manufacturers<br><br>This is important to quantify the exact weight of CFC-12 available for destruction. CRTs would only be issued for this amount, irrespective of the total weight of the destruction stock |
| Transfer manifests of stocks from the collection/scrapping centers to the recycling centers | Available |
| Freight bills and any other transactional payment information | Needed before exporting as well as before Project Listing |
| Purchase orders, purchase agreements, packing lists, bills of lading, or any such information which can establish the ownership of the stocks | Dependent on whether ownership is transferred to a project developer or it remains vested with the scrapping/recovery centers, requisite documents have to be provided before exporting as well as before Project Listing |
| PROJECT MONITORING SYSTEMS | |
| Details of the project monitoring systems starting from the aggregation of ODS quantities from the centers into ISO tanks and export until the end of all destruction activities | All documents specified in CAR requirements must be uploaded into the Reserve's ODS Tracking System. Can be done by project developer |

The conclusion of this gap analysis is that apart from the need to secure special export authorization there are no major hindrances in Mexico's current system of ODS management and control which could prevent it from proceeding with and successfully executing an ODS destruction project under CAR.

# APPENDIX

# Appendix 1

# Mexico's Efficient Lighting and Appliance Program

Mexico follows a subsidy oriented electricity distribution regime. Domestic consumers in the country pay only 58% of the cost of electricity. On average, the annual electricity subsidy of the nation for the period 2005-2009 was approximately US$ 15.3 billion (Praz, 2011) which is a huge cost to the national exchequer. In its efforts to reduce the subsidy bill and contain the rising demand for electricity, the Mexican government launched ELAP.

**Objective of ELAP**

The objective of the Efficient Lighting and Appliances Project is to promote Mexico's efficient use of energy and to mitigate climate change by increasing the use of energy-efficient technologies at the residential level, partly through the replacement (including collection and scrapping) of approximately 1.7 million old and inefficient appliances (refrigerators and ACs) over a four-year period. The project forms a part of the Government's national energy efficiency program.

**Project cost and financing[30]:**

The estimated total cost of the appliances component of ELAP is US$602.998 million, composed of (i) IBRD US$194.998 million, (ii) CTF US$50 million, (iii) NAFIN US$127 million, (iv) Government of Mexico US$55 million and (v) Consumers US$176 million, complemented by a US$35 million Guarantee Facility, of which US$30 million is funded by Government of Mexico and US$5 million by GEF. Resources from the IBRD Loan to the Government will finance the vouchers, resources from the CTF Loan to NAFIN will support the credits, and resources from the GEF grant will capitalize the Guarantee Facility, as follows:

> **Financing of vouchers for low-income consumers** (including IBRD US$194.998 million). Provision of vouchers as instant discounts to low-income consumers to improve their ability to pay for the replacement of old and inefficient appliances with more energy-efficient appliances.
>
> **Financing of NAFIN's credit line** (including CTF US$50 million). Provision by NAFIN of credits at favorable interest rates to low-income and other qualifying consumers to pay for the replacement of old and inefficient appliances with more energy-efficient appliances. A related Guarantee Facility protects NAFIN from credit defaults by consumers.
>
> **Capitalization of the Guarantee Facility** (including GEF US$5 million). Provision by SENER of funds to capitalize the existing Guarantee Facility to issue credit guarantees to NAFIN, in support of its lending under the Appliances Replacement Program. The intent of this Guarantee Facility is to protect NAFIN from credit defaults by consumers.

**Overall organization of the ELAP project:**

The Secretaría de Energía (SENER) is responsible for overall oversight, and is the World Bank's main counterpart for the project. SENER is composed of several directorates, of these, the Directorate General for Distribution and Supply of Electricity and Nuclear Resources (DGDSENR) and the Directorate General for Generation, Conduction and Transformation of Electricity (DGGCTE) holds the principle responsibility of the ELAP project.

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[30] The material for this appendix is directly drawn from the World Bank October 2010 Project Appraisal Document.

As head of the energy sector, SENER is largely a regulatory and policy development agency with limited capabilities to implement projects. SENER faces operational and budgetary constraints, requiring that other entities participate in the implementation of the project. In this context, the implementation arrangements rely on several entities in addition to SENER: FIDE, CFE and NAFIN.

**Implementing agencies.** DGDSENR and DGGCTE are responsible for the design and overall oversight of the appliance replacement program. In this regard, DGDSENR and DGGCTE provide guidance on strategic issues such as the structuring of the voucher program and of the credit line, and the eligibility criteria for households.

SENER delegates to FIDE, as the Operator of the Component, the responsibility for ensuring compliance with the Operational Manual, and for interacting with and supervising the retail stores that sell the new appliances and dispose of the old ones. This supervision process includes telephone calls, periodic check-up visits, review of processes, and distribution of surveys to the beneficiaries. Through its regional offices, FIDE is also responsible for supervising the adequate scrapping of the appliances by the scrapping centers in accordance with the requirements of an environment management plan. For implementing this component, FIDE receives a percentage of the total cost of the program (between 1-2% of the approved credits and 1% of the vouchers redeemed).

**Distribution/Replacement Process:**
Consumers who are eligible for the replacement program acquire a new appliance from eligible retail stores by using the instant discount voucher and/or credit. The consumers provide to the retailers their electricity bills for scanning to consult with the database of the Federal Electricity Commission (CFE) to determine the consumer's eligibility and the amount of the instant discount voucher. Consumers can also apply directly at the store for the NAFIN credit. Consumers purchase qualifying appliances from eligible retail stores in Mexico. Eligible retail stores sell the appliances to eligible consumers, exchange the newly purchased appliance for the old and inefficient appliances, which are collected and scrapped. After a beneficiary requests the voucher and/or credit at the participating store, the store checks the eligibility of the claim in CFE's software and database system and, when eligibility is confirmed, makes the sale. Subsequently, the store delivers the new appliance to the consumer's residence.

**Monitoring and Oversight:**
Effective monitoring and oversight procedures within the program design will help to ensure the economy and efficiency of the program. The Operator monitors the program in part through the SIA (Sistema Integral de Atención) software database, which is used for the process until the appliance is delivered to the consumer and accounts payable are generated by the Operator to the participating stores. The operator also verifies the proper destruction of the old appliances at the scrapping centers located throughout Mexico. The coupling of the voucher directly with the CFE electricity bill ensures that only consumers who meet the electricity consumption requirements can redeem the voucher and access the credit facility.

**Credit Arrangement Modalities:**
Consumers who are eligible for the replacement program apply directly at the store for a credit from NAFIN; the cash incentive/credit percentage is based on the user's level of electricity consumption up to a maximum of MXN$8,700. The consumer signs a credit agreement with FIDE and a promissory note with NAFIN, and then repays the credit in monthly installments directly through the CFE electricity bill; CFE in turn makes the payment to NAFIN. Qualifications to receive the credit are based on various elements, including an assessment of the consumers' credit standing.

**Flow of Funds: Vouchers and Credit Program:**
Approved funds are transferred from the Energy Efficiency Trust Fund on an annual basis to CFE which will transfer funds periodically to the Operator. The Operator receives documentation on the sale from the retailer, verifies the information and determines the payments due to the retailers. The Operator requests the necessary funds from CFE and pays the retailers. With respect to the credit portion, NAFIN transfers the resources requested by FIDE (according to the approved credits) to the Operator, which in turn pays the stores for the "closed" and verified transactions. The consumers pay the remaining balance themselves together with the old appliances to be replaced. As noted above, repayments are made through the electricity bill payments to CFE, which in turn transfers the repayments to the Operator; the Operator then transfers them to NAFIN.

**ELAP - Implementation Processes for the Appliance Component**

**a. Conditions for project participant consumers:**

The project is designed to target the domestic consumers who do not have enough motivation to buy newer domestic RAC appliances. To qualify for the program the consumers have to meet certain criteria (decided upon by FIDE). The main qualifying parameters include:

1. The appliance offered by consumer should be at least 10 years old and have been used for domestic purposes;
2. Refrigerator capacity should be 7 cubic feet or more; and,
3. The compressor of the appliance should be functional

Under the appliance replacement project, support is provided for both appliance replacement and scrapping. The project offers vouchers and credit to lower income families (Level 1 and 2 households[31]) and credit alone to higher income families (Level 3 and 4 households). Vouchers help improve the returns on investments for the lower income households making the investment attractive and on the other hand credit acts as a financing mechanism for high income households; thus motivating an appliance replacement decision. The consumer levels and respective voucher/credit benefits are defined in the following exhibit. The credit offered under the project is available at 12% per annum and payable within a four year period. (Falling under a particular 'Level' is not the sole criterion for availing 'credit support'; the consumer has to meet other criteria to qualify for the credit.)

| Consumer level (Based on electricity consumption in kWh during non-summer months) | Voucher amount for replacement of appliance (Mexican Peso) | Delivery of new appliance + removal of old appliance (Mexican Peso) | Total voucher (Mexican Peso) | Maximum Credit availability under ELAP (Mexican Peso) |
|---|---|---|---|---|
| Level 1 ( 76-175) | 1,800 | 400 | 2,200 | 3,400 |
| Level 2 ( 176-200) | 1,000 | 400 | 1,400 | 4,200 |
| Level 3 ( 201-250) | 0 | 400 | 400 | 5,200 |
| Level 4 (>250) | 0 | 0 | 0 | 8,700 |

**Exhibit 11: Consumer level and Voucher & Credit Limits under the ELAP program**

The consumer's selection of a new appliance is based on predetermined criteria and his/her choices are tied to the appliance offered by him/her for replacement. The appliance selection guidelines under ELAP are described below.

[31] All the households in Mexico are clubbed under four economic categories based on the electricity consumption criteria.

| Consumer Category | Energy Efficiency Norm for New Appliance | Volume Parameter for New Appliance |
|---|---|---|
| Level 1 | Appliance must be at least 5% more energy efficient than the maximum limit set by the current Mexican energy efficiency refrigerator norm | 9-13 $ft^3$, but efficient refrigerators cannot be more than 2 cubic feet larger than their refrigerator offered for replacement by the consumer |
| Level 2 | Appliance must be at least 5% more energy efficient than the maximum limit set by the current Mexican energy efficiency refrigerator norm | 9-13 $ft^3$, but efficient refrigerators cannot be more than 2 cubic feet larger than their refrigerator offered for replacement by the consumer |
| Level 3 | Appliance must be at least 5% more energy efficient than the maximum limit set by the current Mexican energy efficiency refrigerator norm | 9-13 $ft^3$, but efficient refrigerators cannot be more than 2 cubic feet larger than their refrigerator offered for replacement by the consumer |
| Level 4 | Appliance must be at least 5% more energy efficient than the maximum limit set by the current Mexican energy efficiency refrigerator norm | 9 $ft^3$ or larger but efficient refrigerators cannot be more than 2 cubic feet larger than their refrigerator offered for replacement by the consumer |

**Exhibit 12: Consumer level and refrigerators parameters**

ELAP tries to create value for all the program participants: the Government saves on electricity subsidies, the participant retail shop-owners gain as a market for the new products is created, and the consumers receive a new, better functioning appliance that also helps them to save on the electricity bill. The whole process of equipment exchange between the participant consumer and the retailer is completed in 5 to 10 days.

### b. Process initiation by the consumer

Whenever a consumer decides to participate in the program, he/she approaches the ELAP project participant retailers[32]. The retailer requests the consumer to submit the electricity bill. Using CFE's online system, the retailer generates information about the consumer's eligibility under the program (as described under exhibits 11 and 12). The generated information along with the documents supporting the eligibility of the consumer is put into another FIDE controlled information and database management system, the SIA (a web-based system designed by FIDE). It is accessible to all program participants (CFE, FIDE, participating retailers, and scrapping centers). Subject to qualifying as an approved beneficiary, the retailers offer refrigerator options to the consumer. The process is represented in exhibit 13.

### c. Sales process

The retailer checks the eligibility of the consumer for the voucher or credit on CFE's online database system and based on the information carries forward the sale. The consumers also have to produce valid documents that support the retailer's verification. The verification is followed by the retailer registering the new equipment's serial number in the SIA and generates a unique bar code for the customer. The retailer then submits the bills and the barcode in the SIA for the approval of FIDE.

[32] **Retail Store Eligibility Criteria.** Any retail store in Mexico that meets the eligibility criteria is accepted to join the program at any time. The project is designed to increase participation and foster competition among the retail stores willing to increase sales of energy-efficient appliances by taking advantage of the incentives offered by the appliance replacement program, including the opportunity to increase sales to qualifying consumers. The participation of existing retail stores as a vehicle for the appliance replacement incentives program lends itself to an open market scenario in which economy, efficiency and national coverage are established. The Operator signs contracts with the participating stores, defining the rules for the program (the FIDE/Participating Retailers Agreements).

Following this, the new equipment is delivered to the consumers and the old equipment is taken away for delivery to the scrapping centers within or nearest to the consumers' municipality. The unique bar code generated during the process appears on the new equipment and the consumer's subsequent electricity bills.

### d. Payment process

The retailer delivers the new refrigerator to the consumer and collects the old appliance from the household to deliver it to the scrapping center.

The scrapping center scans the barcode and checks the operational condition of the appliance and notes down its details (i.e., brand, color, model and serial number). Upon verification, the compressor of the equipment is checked, and standardized procedures are followed to ascertain its capacity. Once the required conditions are fulfilled, the collection centers issues a letter of acceptance to the retail shop; the retail shop owners submit this letter to the FIDE to receive full price of the new refrigerator. FIDE in turn collects the cost of the appliance from the consumers through a payment mode that is linked to the consumer's electricity bill. Consumers can choose the time period over which they want to pay back the Government, the maximum being four years. The new appliance is offered to the consumer at a discount.

FIDE pays the retailer an amount equivalent to the 'voucher' and 'credit'. The retailer also receives money against the payments made to the scrapping center (this is on the basis of verification of proper delivery of the old appliance to the scrapping center).

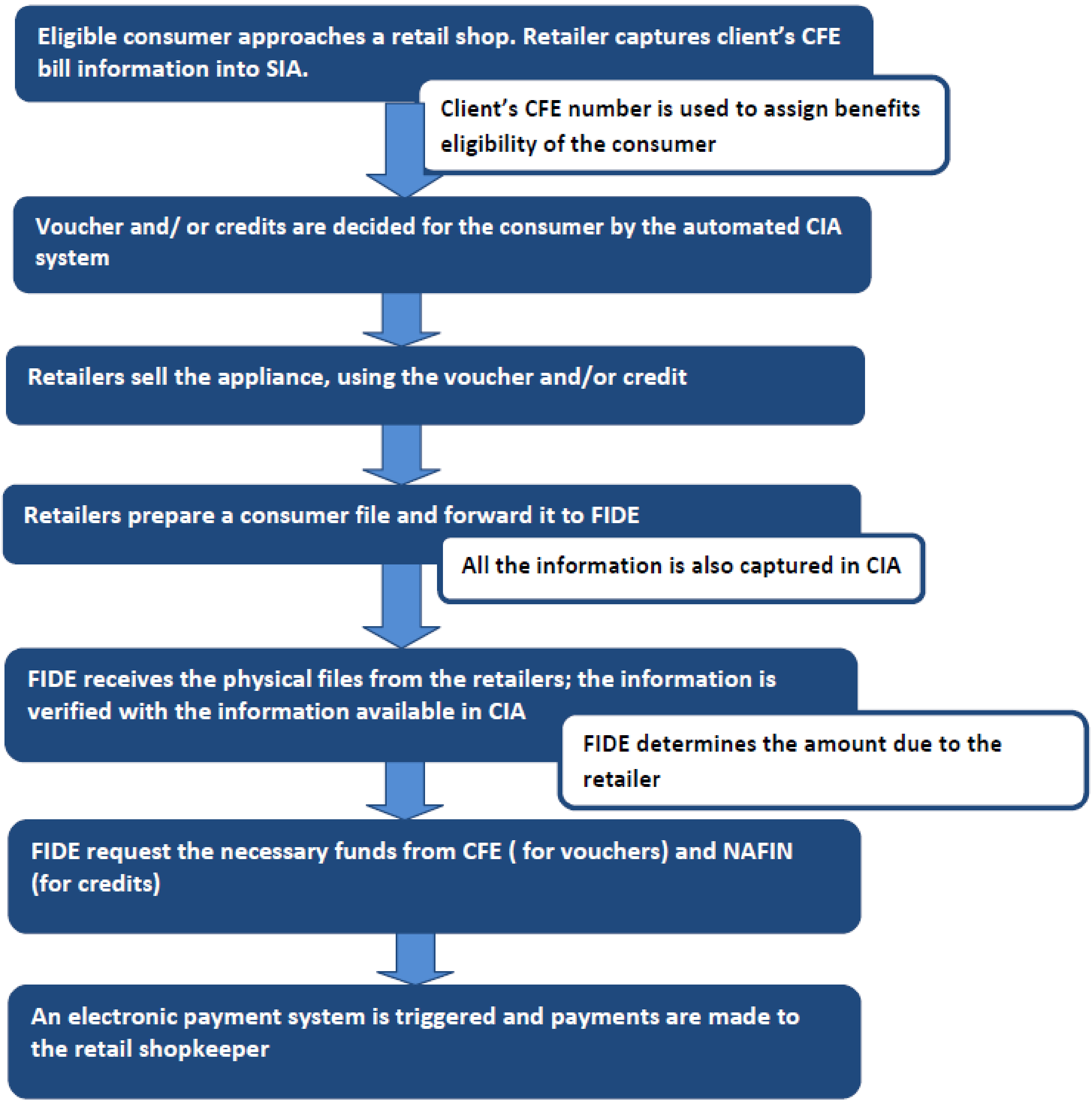


Exhibit 13: Appliance exchange program design (World Bank 2010a)

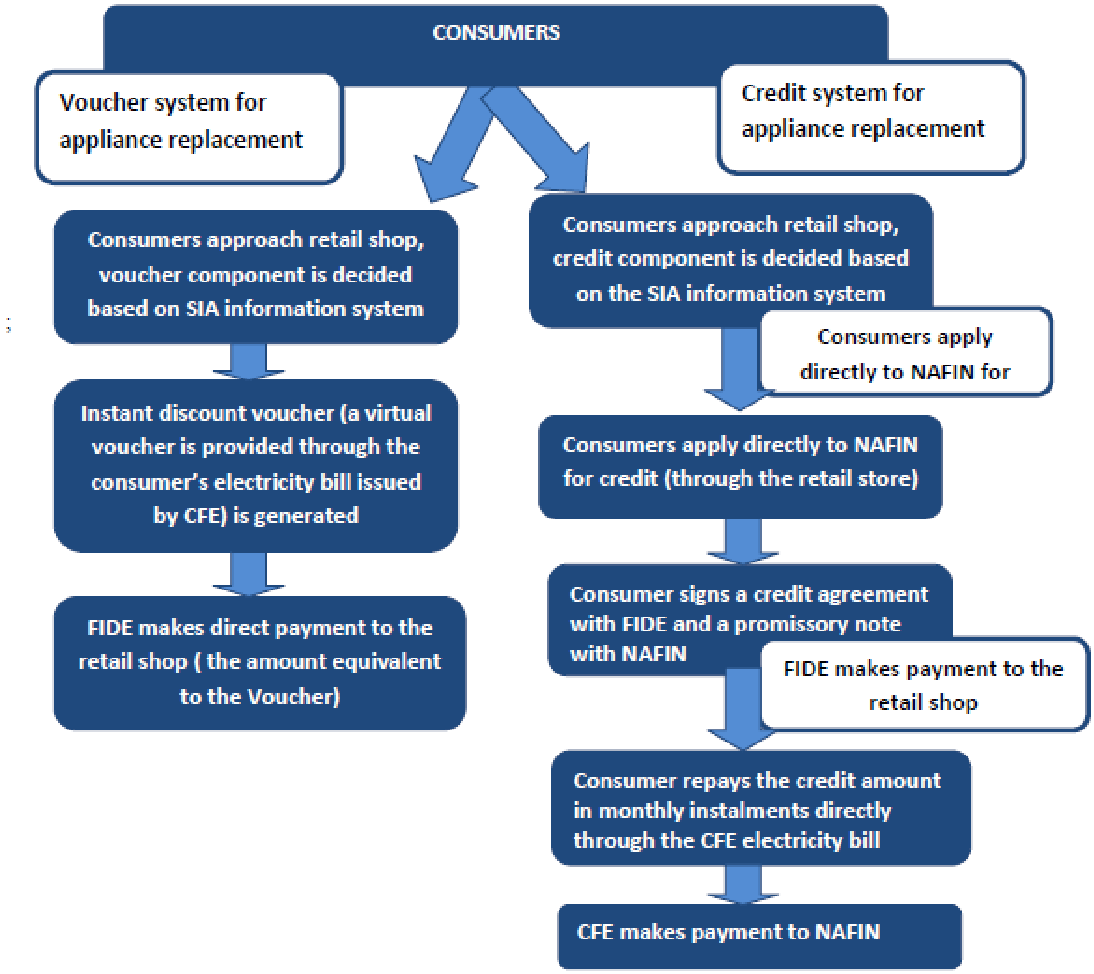


**Exhibit 14: Appliance exchange- Voucher and credit system (World Bank 2010a)**

**Dismantling of the old equipment and recycling:**

The appliance replacement program creates a stock of used inefficient appliances. These old appliances need to be dismantled in order to prevent them from flowing back to the market. To ensure systematic dismantling, the scrapping centers have been promoted under ELAP. These centers provide dismantling services for the RAC appliances that are collected from the consumers. These centers receive a financial incentive of US$ 18.00 per refrigerator from FIDE for dismantling operations of the collected refrigerators and air-conditioners. These centers remove the recyclables and recover the refrigerant gases from the appliances. The parts which do not find a market are sent to landfills. The gases thus collected are stored and sent to centers having gas-purification facilities (recovery centers). These centers are equipped to remove oil, water, metallic particles and ions to try to achieve more than 97% purity in the collected gases.

The recycling related information has to be uploaded by the respective dismantling center in the online project management systems of SEMARNAT, which is known as the SISSAO[33]. The recycling center follows a standard process. The collection centers have to do this operation mandatorily on the same day the refrigerator is received and to record the same in the SIA.

[33] The SISSAO system can be accessed online at http://sissao.semarnat.gob.mx/sissao

The gases collected during the process are CFC-12, HCFC-22 and HFC -134a. Of the collected and purified ODS gases, only HFC 134a is saleable as its supplies are limited, whereas CFC-12 has found no market as the new generation equipment does not use this gas. Recycled HCFC-22 is costlier than the virgin HCFC-22, hence cannot be sold.

The appliances deposited by the consumers have to be dismantled to ensure that they are permanently retired. The metal and plastic recovered during dismantling are sold, and the gases recovered from the appliances are stored, in absence of any market for recycled CFC-12 and HCFC-22.

FIDE maintains a control over these scrapping and recovery centers by carrying out regular verification of its information and operations. Within six months of extraction the collected gas has to be transferred to the SEMERNAT approved recovery center. In addition, there is also a broad program for training the technicians. The centers have also been provided with Standard Operation Procedures (SOP) and various other manuals and literature by both FIDE and SEMARNAT.

All the processes of extraction and storage are standardized but efficiency (amount of ODS collected per refrigerant) is dependent on the technology used by the respective centers. The foams collected in the process of dismantling are weighed and the information is recorded both in the SIA and SISSAO. The foam is sent to landfills as there is no technology available in Mexico which can help recover the CFC-11 contained inside foam.

# Appendix – 2

## Comparison of the VCS and CAR and the Impact on an ODS Destruction Project in Mexico

| Parameter | Difference | Implication for the Mexico ODS Destruction Project |
|---|---|---|
| **Location** | **CAR** requires that ODS that is sourced from Article 5 countries must be imported into the US and destroyed within the US or its territories whereas **VCS** allows ODS to be sourced and destroyed internationally | Using the CAR standard will mean that there are additional costs, associated with transporting the ODS to the US from Mexico and additional overhead in securing export permits from Mexico and import permits from the US |
| **ODS Eligibility** | Under the **VCS,** only ODS recovered from equipment at servicing or end-of-life is allowed whereas under **CAR,** stockpiled virgin (but now only government-owned) or used ODS refrigerant, including government stockpiles of seized ODS is allowed | In this proposed project, only CFCs collected from old refrigerators is required to be destroyed Therefore, both standards are equally applicable |
| **Current status of ODS destruction VERs** | As per the information available in the **VCS** project database, no project is currently (mid-2011) being processed under the VCS ODS destruction methodology whereas there are 12 projects under the two ODS project protocols of **CAR** | Case studies can be referred to if the project is registered under the CAR. No such precedent is available under VCS |
| **Salability of ODS destruction VERs** | **VCS** is currently the most popular standard in the Voluntary Market. However, due to a profusion of VCS credits in the market, prices have dipped from the US$6-8 level to as low as US$0.6 per ton. In addition industrial gas projects, which would include ODS destruction and which usually cover large quantities of CERs but have generally less visible co-benefits are not favored by buyers.<br><br>Prices for Climate Reserve Tons (CRTs), which are offsets verified under the **CAR** protocols, are currently valued the highest in the voluntary market (barring Gold Standard offsets). The prices are typically in the range of US$7-8 a ton. These offsets are very attractive to US buyers as CAR is the most likely system to be accepted into any future US emission trading scheme. | Currently VCS credits are expected to sell at a conservative figure of US$0.4 per ton. On the other hand, CAR credits can be conservatively expected to sell at a minimum of US$3.50 per ton.<br><br>Therefore, considering the costs involved and the volume of ODS to be destroyed, the project is only expected to be profitable if the CAR protocol is followed. |

# Appendix – 3

# Pilot of ODS Destruction in Cement Kiln in Mexico

On 9th and 10th October, 2008, a pilot test for ODS destruction was conducted at the cement kiln of ECOLTEC. The plant is located in Tecoman, Colima in the west of Mexico. The pilot test was coordinated by the National Ozone Unit, SEMARNAT and ECOLTEC technicians.

General objectives of the pilot test were as follow:

i. To carry out the installation and preparation of an injection of CFC gases to the main burner of the kiln.
ii. To establish the most favorable operating conditions of the kiln through the execution of tests.
iii. To carry out tests for gas feeding using at least two rates (kg/h) as indicated through other international experiences, namely in Japan and Malaysia.
iv. Stack monitoring of the pollutant emissions as required by local regulations and also to compare the results versus the standard limits.
v. To carry out analysis of the chloride contents and fluorides in clinker from the ECOLTEC cement kiln

For the test, DuPont provided a lot of 794 kg of ODS mixture with a composition as follows:

**ODS Mixture Composition**

| Compound | % |
|---|---|
| CFC-12 | 34.2 |
| HCFC-22 | 65.8 |
| Air | 3.0 |
| Oil | 8.0 kg |

Additionally, pipelines were provided with two pressure gauges and two valves in the gas flow path to control the feed rates. The engineering specifications of the kiln of are as follow:

| KILN DETAILS | SPECIFICATIONS |
|---|---|
| Type | Dry with pre-heater |
| Fuels | Petroleum coke and carbon |
| Heat consumption | 850 kcal/kg of clinker |
| RM feed rate | 20-220 tons/h |
| Production | 3,130 ton/h |
| Dimensions | L= 55m D= 4.4 m |
| Burner type | Rotaflam 60% air axial; 30% air radial 50mbar |
| Pre-heater type | 4 stages |
| Cooler type | Screens |

The gas was introduced at the suction of the primary air blower. This way the ODS enters to positive pressure along with the solid fuel directly into the burner.

In order to fulfill all the requirements planned for the destruction tests and the NOM-040-SEMARNAT-2002 emissions limits, stack sampling included:

i. Continuous Emission Monitoring System (CEMS) **-** The kiln´s stack has a CEMS for the continuous measurement of particles, HCI, CO, $CO_2$, NOx, HCT, $NH_3$, $S0_2$, $O_2$, $H_20$.

ii. Complementary Stack Sampling **-** Additionally an accredited lab was contracted for the stack sampling for the determination of metals, Dioxins and Furans, HF, as well as the concentration of the ODS (CFC-12 and HCFC-22).

iii. Raw materials and Clinker **-** The main raw materials and clinker were also analyzed for metals, chlorides and fluorides.

iv. Complementary registries **-** The company counts on a continuous system of registration of the operational data, such as the feed rate, raw material rate, fuels' consumption and temperatures at different points in the whole system.

A second test executed the next day was done with a higher feed rate. In the following table, the emissions results and a comparison vs. standard limits is presented. As it can be seen, emission results fulfill standard limits satisfactorily.

| **PARAMETER** | **REFERENCE CONDITIONS mg/m$^3$ bs @ 25°C, 101325 Pa, 7% vbs O2** | | |
|---|---|---|---|
| | **Monitoring Type** | **Result** | **Standard** |
| CO | Continuous | 483 | 4000 |
| $CO_2$ | | 21.9 | NA |
| NOx | | 923 | 1200 |
| TOC | | 29.1 | 70 |
| $NH_3$ | | 3.9 | NA |
| HCl | | 5.6 | 70 |
| $SO_2$ | | 17.9 | 1200 |
| Particulates | | 4.3 | 31.65 |
| Dioxins & Furans (pg/m3) | Point | 0.0003 | 0.2 |
| Antimony (Sb) | | 0.0059 | 0.7 |
| Arsenic (As) | | | |
| Selenium (Se) | | | |
| Nickel (Ni) | | | |
| Magnesium (Mn) | | | |
| Lead (Pb) | | 0,0109 | 0.7 |
| Chromium (Cr) | | | |
| Zinc (Zn) | | | |
| Cadmium (Cd) | | <0.0001 | 0.07 |
| Mercury (Hg) | | <0.0002 | 0,07 |
| HF | | <0.078 | NA |
| CFC-12 | | <0.0024 | NA |
| HCFC-22 | | <0.0017 | NA |

# Appendix – 4

## Companies that can serve as Project Developers for an ODS Destruction Project under CAR

Currently, there are seven US-based companies which are completing or have completed ODS destruction projects under CAR. These include:

1. EOS Climate Inc.
2. Coolgas Inc.
3. Reclamation Technologies Inc. (RemTec)
4. Refrigerant Exchange (Refex)
5. Pure Chem Separation LP
6. Environmental Credit Corporation (ENVcc)
7. Wilshire Standard Offsets, LLC (WSO)

Out of these 7 companies:

- Only EOS Climate, Coolgas, RemTec and Pure Chem have registered projects, and Refex has successfully completed verification of their projects;
- ENVcc and WSO projects are at the listed stage (as of 2011) and have not yet completed verification;
- The Coolgas project involved importing and destroying virgin CFC stocks from India but this was implemented before the CAR Article 5 ODS Project Protocol was approved, therefore, the market response to their offsets is somewhat questioned;
- As ODS imported into the US is considered as a hazardous waste and because RemTec does not operate a hazardous waste facility, destruction cannot take place at RemTec's facility.

To date, EOS, Pure Chem and Refex and their technology partners have successfully completed ODS destruction projects with compliance with all relevant US laws and regulations including the Clean Air Act, the Resource Conservation and Recovery Act (for hazardous material and hazardous waste), and US Department of Transportation requirements.

There are no limits on the geographic location of a project developer under CAR and although the seven companies listed above are known in the CAR-ODS destruction context, there may be other qualified project developers based in countries outside the US that could undertake an ODS destruction project under CAR on behalf of ODS-owners/holders.

# Appendix – 5
# Testing and Safe Storage of ODS Recovered from Refrigerators under ELAP

The ODS recovered from the old appliances is collected and stored while focusing on maintaining safety and avoiding emissions and wastage. Regular leak checks are conducted by the technicians for the cylinders (which also have been hydro- tested by the manufacturers). Collected refrigerant gases are subject to the following processes:

- **Purity Analysis** – This is done by using electronic analyzers (see picture to the right) which are very accurate and can identify CFC-12, HCFC-22 and HFC-134a apart from air and Hydrocarbons. It gives the results as PASS if the majority gas component has a content of more than 97%, else it shows fail. Gas analyzers are calibrated each time before a test. The results are then printed and kept as records.


- **Quantity determination** – This is done by weighing the cylinders before and after filling the cylinders with gases.

- **Storage of the gases** – The smaller scrapping centers store the gases which appear as PASS in specific cylinders, which range from 13.6kg to 61kg and sometimes 105kg. The gases which appear as FAIL are labeled as R-Contaminated and stored in dedicated (color coded) cylinders. They are then transferred to the 14 recycling centers within 6 months, where they are further subjected to processing for removal of the oil, water, ions and acids. After that they are stored in specific color coded cylinders. Leakage is checked by using leak detectors periodically.

# REFERENCES


Arroyo-Cabanas F.G., J.E.Aguillo´ n-Martı´nez , J.J.Ambrı´z-Garcı´a and G.Canizal. 2009. *Electric energy saving potential by substitution of domestic refrigerators in Mexico.* Energy Policy 37 (2009) 4737–4742

Climate Action Reserve (CAR). 2010. Article 5 Ozone Depleting Substances Project Protocol: Destruction of Article 5 Ozone Depleting Substances Banks: Version 1.0. Available Online:
http://www.climateactionreserve.org/wp-content/uploads/2009/03/A5_ODS_Protocol_V1.0_050710_package1.pdf

Commission for Environmental Cooperation of North America (CEC). 2011. *Legislation in Mexico.* Web Page: http://www.cec.org/ods/en/module01/cec_odspolicy_m01t041p01_e.asp

Ecosystem Marketplace and Bloomberg New Energy Finance. 2011. *Back to the Future: State of the Voluntary Carbon Markets*

Environmental Investigation Agency (EIA). 2009. Recovery and Destruction of ODS banks: Immediate action for Global Climate Protection. Available Online
http://www.eia-international.org/files/reports180-1.pdf

IPCC. 2007. *Climate Change 2007 – The Physical Science Basis. Contributions of Working Group I to the Fourth Assessment Report of the IPCC.* Available Online
http://www.ipcc.ch/ipccreports/ar4-wg1.htm

IPCC/TEAP. 2005. *Special Report on Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons*

The Multilateral Fund for the Implementation of the Montreal Protocol.. 2011. *About the Multilateral Fund.*
Web Page: http://www.multilateralfund.org/about_the_multilateral_fund.htm

Praz, Anneliese Gabrielle Carbonell. 2011. *Evaluation of Air Conditioning Replacement Programs in Mexico: Energy, Economic and Environmental Impacts.* Available Online
http://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/3637/Carbonell-Praz%20Final%20MP.pdf?sequence=1

UNDP. 2011. *Management and Destruction of ODS Banks.*
Web Page: http://www.undp.org/ozone/management-and-destruction.shtml

UNEP. 2006. *The Montreal Protocol on Substances that Deplete the Ozone Layer. As contained in the Handbook for the Montreal Protocol on Sub-stances that Deplete the Ozone Layer, 7th Edition.* Available Online
http://ozone.unep.org/Publications/MP_Handbook/Section_1_The_Montreal_Protocol/index.shtml

UNEP. 2010. *Key Achievements of the Montreal Protocol to Date.* Available Online
http://ozone.unep.org/Publications/MP_Key_Achievements-E.pdf

UNEP. 2011. *Country Status of Ratification.* Web Page:
http://ozone.unep.org/Ratification_status/ratif_by_country.shtml?cntryname=Mexico&submit_country=Submit

UNEP. Technology and Economic Assessment Panel (TEAP): Task Force Decision XX/7. 2009. *Interim Report Environmentally Sound Management of Ozone-Depleting Substances.* Available Online
http://ozone.unep.org/teap/Reports/TEAP_Reports/teap-june-2009-decisionXX-7-task-force-report.pdf

UNEP. Multilateral Fund for the Implementation of the Montreal Protocol.. 2008. *Study on the Collection and Treatment of Unwanted Ozone Depleting Substances in Article 5 and Non-Article 5 countries.* Available Online
http://ozone.unep.org/Meeting_Documents/oewg/28oewg/ICF_Study_on-Unwanted_ODS-E.pdf

U.S. Agency for International Development Mexico Mission. 2010. *Clean Energy & Climate Change opportunities.* Available Online
http://pdf.usaid.gov/pdf_docs/PNADS950.pdf

U.S Environmental Protection Agency (US EPA). 2011. *Destruction of Ozone Depleting Substances.* Web Page:
http://www.epa.gov/ozone/title6/destruction.html

Western Climate Initiative (WCI). 2011. *WCI Partners and Observers.* Web Page:
http://www.westernclimateinitiative.org/wci-partners-and-observers-map

World Bank. 2006. *Implementation Completion and Results Report on a Loan/Credit in the amount of US$ million 5.70 to Mexico for Third Ozone Depleting Substances Phase Out (Montreal Protocol).* Available Online
http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2007/02/09/000020953_20070209111129/Rendered/PDF/ICR130.pdf

World Bank. 2010a. *Beyond the Sum of Its Parts: Combining Financial Instruments for Impact and Efficiency.* Available Online
http://siteresources.worldbank.org/EXTENERGY2/Resources/DCFIB3.pdf

World Bank. 2010b. *Study on Financing the Destruction of Unwanted Ozone-Depleting Substances through the Voluntary Carbon Market – Final Report.* Prepared by ICF International. Available Online
http://siteresources.worldbank.org/INTMP/Publications/22587937/FinancingODS_Destruction.pdf

World Bank. 2010c. *Project Appraisal Document on a Proposed Loan, a Proposed GEF Grant, and a Proposed Clean Technology Fund Loan to Nacional Financiera with a Guarantee of the United Mexican States for an Efficient Lighting and Appliances Project. Available Online.*
http://www.worldbank.org/projects/P106424/efficient-lighting-appliances?lang=en