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The Montreal Protocol's Multilateral Fund and Sustainable Development

Ralph Luken * and Tamas Grof
United Nations Industrial Development Organization, P.O. Box 400, A-1400 Vienna

Abstract:

The 1987 Montreal Protocol is widely recognized as a global environmental accord that has produced tangible results in terms of reductions in ozone-depleting substances. In addition, and this has been largely unrecognised and so far undocumented, there have been other benefits best characterized within a sustainable development framework. Aiming to identify such sustainable 'side-effects', this article reviews 51 out of 930 projects implemented by UNIDO, one of the four implementing agencies of the Multilateral Fund for the Implementation of the Montreal Protocol. Within this sample, the 44 investment projects have reduced ozone depleting potential and global warming potential. Some projects have reduced atmospheric emissions and contamination of groundwater. Other projects have increased the competitiveness of enterprises in domestic and international markets and have sustained and in a few cases created employment opportunities. Others, fewer in number, have contributed to environmental problems, caused difficulties in maintaining productivity and quality standards and decreased the number of employment opportunities because of the need to rationalize manufacturing processes.

We conclude that potential contributions from Multilateral Fund investment projects to sustainable development could have been amplified with guidance for the technical staffs of the implementing agencies. Concerned with optimising resources and orchestrating global environmental efforts, we therefore suggest to systematically and explicitly integrate sustainability parameters into the future funding for mitigation of global environmental problems. Rethinking implementation strategies would be of particular value for Global Environment Facility industry related projects in the focal areas of climate change, international waters, ozone depletion, and persistent organic pollutants. There clearly is a potential to generate multiple beneficial impacts beyond the environmental objective if we mutually design, implement, and evaluate projects with the objective of maximizing their contribution to sustainable development.

Keywords: Global Environment Facility, Montreal Protocol, multilateral environmental agreements, sustainable development, technology transfer, and global.

Abbreviations: CO_2 – carbon dioxide; CFCs—chlorofluorocarbons; Global Environment Facility (GEF); GWP- global warming potential; HAPs- hydrocarbon aerosol propellants; HCFCs –hyrdochlorofluorocarbons; HFCs- hydrofluorocarbons; IPCC- Intergovernmental Panel on Climate Change; LDC- liquid carbon dioxide;
Multilateral Fund for the Implementation of the Montreal Protocol – MLF; ODP ozone depleting potential; ODS – ozone depleting substances; UNDP- United Nations Development Programme; RMP- Refrigeration Management Plan; UNEP- United Nations Environment Programme; UNEP/OS- United Nations Environment Programme/ Ozone Secretariat; UNIDO- United Nations Industrial Development Organization; USEPA- United States Environmental Protection Agency.

* Corresponding Author. *E-mail address*: R.Luken@unido.org / skipluken@yahoo.com. The views in this paper reflect those of the authors and not necessarily those of UNID0.

1. Introduction

The Montreal Protocol on Substances that Deplete the Ozone Layer of 1987 (Montreal Protocol) is widely seen as a global environmental accord that has produced tangible results (Anderson and Sarma, 2002). Implementation of the Montreal Protocol has reduced the global consumption of ozone depleting substances (ODS) by more than 90 percent (UNEP/OS, 2004). By the end of 2002 industrialized countries have reduced their ODS consumption by more than 99 per cent and developing countries have reduced their consumption of ODS by slightly more than 50 per cent. Most of the reduction in ODS consumption in developing countries is attributable to projects implemented by the four implementing agencies (United Nations Development Programme, (UNDP), United Nations Environment Programme (UNEP), United Nations Industrial Development Organization (UNIDO), and World Bank) of the Multilateral Fund for the Implementation of the Montreal Protocol (MLF).

Reading about the impacts of the MLF in reducing consumption of ODS in developing countries, we are surprised by how narrowly focused are the descriptions of the results of ODS phase out projects. The reports available from the Executive Committee of the MLF and the three agencies executing MLF funded investment projects, UNDP, UNIDO, and World Bank, focus almost exclusively on the amount of ODS consumption reduced and the costs and cost effectiveness of various chemical substitutes. The annual reports of the MLF Executive Committee, the latest from November 2003, describe total reductions in ODS consumption and costs as well as a host of fund raising and administrative matters (UNEP, 2003). The sectoral evaluations undertaken by the MLF Secretariat over the past few years (on aerosols, compressors, foams, solvents, and refrigeration) only mention in passing other environmental issues and economic (productivity) and social aspects of ODS phase out projects (UNEP, 1999, 2001a-c, and 2002). The World Bank, which has received the most funding from the MLF, has only recently evaluated its implementation of MLF projects (World Bank, 2004) (Table 1). The focus of its evaluation is almost exclusively on administrative matters, particularly those with financial intermediaries that disperse investment funds for plant level conversions. UNIDO's comprehensive review of the first ten years in implementing MLF funded projects focused almost exclusively on the effectiveness and efficiency of its sectoral programmes for phasing out ODS in the manufacturing and agricultural sectors (UNIDO, 2003). The United Nations Development Programme, which uses the Office of Programme Services to disperse funds for plant level conversions, has only now undertaken a review of its implementation of MLF funded projects (Carvalho, 2004). In all of these published or planned reports there is virtually no mention of other environmental impacts, not to speak of potential economic and social benefits or dis-benefits of plant level conversions. This lack of descriptions and reporting on the part of the implementing agencies is even more surprising given the decade long attention to sustainable development, as put forward by the United Nations Conference on Environment and Development (Rio, 1992) and the World Summit on Sustainable Development (Johannesburg, 2002).

Insert Table 1

Several articles and at least two books have reviewed the achievements of the Protocol so far and in particular the varied issues associated with its implementation in industrialized and developing countries. Both books (Anderson and Sarma [2002] and Parson [2003]) are basically comprehensive histories of the international effort to reduce ODS. More focused reviews, addressing in varying degrees implementation issues in developing countries, include Biermann and Simonis (1999), Brown, Weiss, and Jacobson (1999), French (1997), Gray (2003), Oberthuer et. al. (2000), O'Connor (1991), and Zhao and Ortolano (1999). Like the reports by MLF and its Implementing Agencies, the books and some of the articles mainly discuss the reductions in ODS consumption and production. In all the publications, as deeply they may go into their subject matters, there is little mention of other environmental impacts, however, or of economic and social impacts resulting from the implementation of MLF funded investment projects.

In light of this relatively narrow focus on the reduction in ODS as such in MLF funded investment projects, while ignoring other impacts, UNIDO decided to complement its major technology review cited above focused ten-year by documenting a wider range of potential sustainable development benefits and also dis-benefits that resulted from implementing MLF projects (UNIDO, 2002). Unlike the World Bank, which disburses MLF funds for plant level conversions to financial institutions in developing countries, assigning to them conversions on the plant level, and UNDP, which mainly contracts out the design and implementation of plant level conversions to the UN Office of Programme Services, UNIDO has an in-house engineering capability and hands on approach to implementing MLF funded projects. Because of this UNIDO gained considerable knowledge of the wider implications of MLF projects it implemented. UNIDO's technical personnel collects information on baseline economic and employment parameters in the course of project preparation and often advises plants, in light of the Organization's mandate to enhance the contribution of industry to sustainable development, about transforming the manufacturing process into a more productive and market oriented operation. Initial direct contact with plants also allowed for follow up, documenting changes in baseline performance in manufacturing and agricultural operations. Reviewing these materials, the authors were therefore able to select out of the total of 931 UNIDO projects funded by the MLF, those 51 projects that were densely enough documented to be included in this review. To a limited extent the sectoral evaluations undertaken by the MLF, cited above, were integrated into these materials. The rationale for selecting the 51 projects —approximately five per cent of the total number of UNIDO MLF funded projects— was simple: we chose those with reasonably complete pre-project preparation worksheets and with documented post performance economic and employment performance. Out of the 51 projects, which were mostly in the refrigeration and foam sectors, 44 were investment projects, which were about ten per cent of the total number of investment projects; they accounted for about 21 per cent of the amount of investment funds disbursed and about 28 per cent of ODP tons phased out. (Annex 1 lists all the UNIDO projects included in our review; numbers in brackets throughout the article refer to the individual projects as listed).

Reviewing these UNIDO projects, we examined a range of environmental, economic, and social implications, thereby following UNIDO's mandate to enhance the contribution of industry to sustainable development. UNIDO basically assumes that industry contributes to sustainable development where there is a pattern of development that balances a country's concerns for competitiveness, for social improvement, and for environmental soundness. Either absolutely or comparatively, such development should accomplish three things: (i) it should encourage a competitive economy with industry producing for export as well as the domestic market; (ii) it should create productive employment with industry bringing long–term employment and increased prosperity, and (iii) it should protect the environment with industry efficiently utilizing non-renewable resources and conserve renewable resources while remaining within the functional limits of the ecosystem (UNIDO, 1998). In practice, UNIDO technical cooperation projects, such as MLF funded investment projects, foster sustainable development by targeting at least one of the three dimensions of sustainable development—the environment in this case— while at the same time contributing to, or at least taking into consideration, the other two dimensions.

2. History

In 1985, scientific concerns about damage to the ozone layer prompted governments to adopt the Vienna Convention on the Protection of the Ozone Layer, which established a first international legal framework for action. Then in 1987, international negotiators met again, this time in Montreal, to adopt legally binding commitments, finally putting into effect the Montreal Protocol on Substances that Deplete the Ozone Layer, which required that industrialized countries reduce their consumption of chemicals harming the ozone layer. As a result of worsening environmental conditions and increased scientific information, more demanding phase-out requirements were added to the Montreal Protocol in the form of amendments, adopted in London (1990), Copenhagen (1992), Montreal (1997), and Beijing (1999).

As of June 2004, 187 countries have ratified the Montreal Protocol. It sets a time schedule to "freeze", reduce, and eventually phase out completely consumption and production of ozone depleting substances (ODS). It also requires all Parties to ban exports and imports of substances controlled by the Montreal Protocol to and from non-Parties.

Since the Montreal Protocol is in place, the production and consumption of chlorofluorocarbons (CFCs), of halons as well as other ozone depleting chemicals have been almost completely phased out in industrialized countries; furthermore, a schedule has been introduced to eliminate the use of methyl bromide, a pesticide and agricultural fumigant with particularly devastating ozone depleting effect. Developing countries whose annual per capita ODS consumption is less than 0.3 kg, so called Article 5 Parties, obviously working not only under different environmental, but also economic and social preconditions, participate in the Montreal Protocol, under different phase-out schedules. They have a grace period before phase-out measures apply to them, recognizing both their special need for industrial development and their relatively small production and consumption of ODS[1]. Developing countries agreed to freeze their CFC consumption as of July 1999, based on 1995-1997 averages, aiming to reduce consumption by 50 per cent by January 2005 and by 85 per cent by January 2007, to eliminate fully CFC consumption by January 2010. Again different percentage reductions and time schedules apply to other ODS, such as halons, carbon tetrachloride, methyl chloroform, and methyl bromide.

Developing countries receive help in meeting their treaty obligations by the four implementing agencies of the MLF, being assisted in strategic planning and policy formulation and getting technical support in project identification, preparation, and implementation.[2] As the financial mechanism to facilitate this work, the MLF was set up in 1990 to cover the incremental costs of complying with the Protocol's provisions.[3]

MLF funds expended for ODS phase out activities were US$ 1.2 billion at end of 2003. The MLF estimates that MLF funded projects already eliminated approximately

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[1] In 1986, production of CFCs in developing countries was less than five percent of the production in industrialized countries (Anderson and Sharma, 2002, p280).

[2] Only three of the four implementing agencies, UNDP, UNIDO, and the World Bank, are executing MLF funded investment projects. In addition bilateral agencies (primarily France, Germany, Italy, and Japan) also assist developing countries with conversion projects under the MLF. The three executing agencies account for over 90 per cent of the implemented conversion projects, the rest is covered by the bilateral agencies.

[3] Incremental costs include incremental capital costs, incremental raw material, and component costs. They are provided for a limited period of time (usually six months for refrigeration projects).

187,000 ODP tons of ODS consumption from the Article 5 countries by the end of 2003 (Table 1)[4].

3. Protecting the environment

3.1 Reducing ozone depletion

MLF implementing agencies measure their accomplishments by the amount of *ODP* phased-out by MLF funded investment projects. In the 13 years that UNIDO has been such an implementing agency, its efforts have cumulatively eliminated 30,300 ODP tons of annual ODS consumption in various sectors, implementing 484 projects by mid- 2004 (Table 2). Of the 51 projects reviewed in detail for this article, 44 were investment projects that reduced ODS consumption by 8,500 ODP tons. Among the 484 investment projects, investments in the refrigeration and foam sectors accounted for 75 per cent of the ODS phased out; among the 44 investment projects reviewed for this article, those in the refrigeration and foam sectors (31 out of 44) accounted for 89 per cent of the ODS phased-out.

Insert Table 2

To the extent that hyrdochlorofluorocarbons (HCFCs) were used as substitutes for CFCs, conversion to them now means a double phase-out strategy because of their high ODP (five to 11 per cent of CFCs).[5] First CFCs are phased out, followed by HCFCs; the latter Article 5 countries are permitted to use up to 2040 (Climate Action Network-Europe, 2002).

3.*2 Reducing global warming*

Replacing the most widely used ozone-depleting substances (CFC-11 and CFC-12) also reduces global warming. Larger GWP reductions occur, however, when CFCs are replaced not by HCFCs and hydrofluorocarbons (HFCs) but by readily available and for the most part natural substances such as hydrocarbons (like n-pentane, cyclopentane, isobutane), ammonia, carbon dioxide, water, and air. These natural substances contribute only minimally (or not at all) to global warming. (For example the GWP of carbon dioxide, which is the relative basis for comparing GWP, is 1.) They are also alternatives to HCFCs, which, as stated above, Article 5 countries are permitted to use up to 2040.

Thus the reduction in GWP resulting from the phase-out of CFCs is offset to some extent by some of the substitutes phased-in, particularly the use of HFCs in the refrigeration and foam sectors (Oberthur, 2001).[6] According to estimates by the Intergovernmental Panel on Climate Change (IPCC, 2001), the Global Warming Potential (GWP) of CFC-11 is 6,300, whereas its most common replacement, HCFC-141b, has a GWP

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[4] Ozone-depleting potential (ODP) is the common denominator of ODSs—a relative index of the extent to which a chemical product may actually break ozone down in the stratosphere. The reference level of 1 is the depletion potential of the chlorofluorcarbons CFC-11 and CFC-12. Releasing a given weight of another product, say Halon-2102 with an ODP of 6.0 would in time deplete six times the amount of ozone as the same weight of CFC-11.The environmental value of removing a given amount of production or consumption of an ODS is its CFC-11 equivalent—obtained as the product of the weight eliminated in tons and the corresponding ODP. Thus, removing one ton of Halon-2102 is as beneficial to the ozone layer as removing 6 tons of CFC-11 or 11 tons of carbon tetrachloride.

[5] In spite of their ODP, HCFCs are preferred to hydrocarbons with no ODP because they are a low cost, easy drop-in substitute and have low or zero toxicity and flammability.

[6] HFCs have a distinct advantage over hydrocarbons in some situations, because of their low or zero toxicity and flammability.

of only 2,100.[7] The GWP of CFC-12 is 10,200, its non-ODS replacement, HFC-134a, comes in at 3,300. The extent of the offset by some substances is best illustrated by estimating the reductions and contributions resulting from all UNIDO refrigeration and foam projects implemented between 1992 and mid 2004 (Table 3). Using the coefficients for CFCs stated above, UNIDO refrigeration and foam projects are estimated to have reduced GWP by approximately 209 million tons of CO_2 equivalents. The contribution of HFC substitutes is estimated to have added 17 million tons of CO_2 equivalents, which means that the phase out of ODP resulted in a 192 million ton (92 per cent) reduction in CO_2 equivalents. In a global perspective, however, this post-project GWP contribution is small. The IPCC estimates that the GWP from all sources (excluding land use and forestry changes) in 31 countries was 15,000 million tons of CO_2 equivalents in 1998 (IPPC, 2001, and USEPA, 2000).[8]

Table 3

3.3 Reducing local pollution problems

Phasing out ODS sometimes helps with other environmental problems, often where their use can have immediate adverse health effects. For example, MLF projects that replace chlorinated solvents with water-based cleaning agents and use closed-cycle hydrocarbon cleaning systems for metal cleaning, also reduce atmospheric emissions of volatile organic compounds. Although such emissions are only a minor contributor to overall urban oxidant pollution, their reduction has improved air quality locally in polluted cities like Cairo Egypt [1] and Mumbai, India [2]. The replacement of chlorinated solvents also reduces the potential for groundwater contamination, a problem that often occurs when solvents are improperly dumped in non-secured landfills. In the fumigant sector, substituting chemical and non-chemical alternatives for methyl bromide reduces health risks to operators and the wider public. Methyl bromide and its derivatives are also potential contaminants of surface and ground water (UNEPa, 1995).

However, other MLF investments appear to have contributed to local pollution problems. For example, equipment has been chosen without full regard to environmental consequences, as has been reported in MLF evaluations of 30 solvent projects. Two projects supporting ozone depletion reductions in China supplied three machines for cleaning highly sensitive electronic equipment that were not supposed to have waste streams, when local inspection showed a more fundamental need for disposal methods for highly polluting products and heavy metal salts (UNEP/MLF, 2001c, p13). The evaluation team therefore strongly recommended that future projects put more emphasis on safety, health, and environmental impacts. In particular, more attention should be paid to the fate of chemical cleaning agents and soils cleaned from equipment parts (UNEP/MLF, 2001c, p20).

4. Competitive Economy

[7] The GWP estimates are for a 20-year time horizon.
[8] The global estimate from IPCC includes 30 industrialized and transition countries. We added an estimate for Japan, which was taken from an EPA report. The global estimate does not include sources in Russia or any developing country.

Central to enterprises having to compete in both domestic and international markets is their ability to readily adjust production processes to changing market requirements. In many cases the occasion for such adjustments correlated with them successfully implementing enterprise-level ODS phase-out. MLF projects helped them replace chemicals and equipment and initiate the reorganization and rationalization of the production process. In other cases they stimulated the redesign of products.[9]

At the start of refrigeration projects, international experts often found production lines with outdated equipment and products that were poorly designed with respect to efficiency and energy consumption. The conversion process hence offered an opportunity to reorganize the entire production process and sometimes also modify the product, taking advantage of new design principles and components that at the same time increase energy efficiency. Of particular necessity in the case of hydrocarbon refrigerants, design changes were often required to ensure the safety of manufacturing processes and products.

For example, a high-end refrigerator manufacturer, Huari Group in China, pioneered the use of hydrocarbon alternatives that also improved productivity [3]. As part of its conversion to cyclopentane insulation foam blowing and isobutane refrigerant, Huari also upgraded its premises and rationalized its manufacturing processes. It erected a new building in an industrial zone at its own expense, investing US$ 0.7 million of its own funds to complement the US$ 2.8 million provided by the MLF. As a result, Huari not only eliminated the use of 338 ODP tons of CFCs. It increased annual production by five per cent and improved labour productivity from 352 to 455 units per worker per year.

CFC phase-out at Pars Appliance Manufacturing, Iran’s largest manufacturer of refrigerators, is another example of improved productivity [4]. This company built a second production hall for the assembly of refrigerator bodies at its own expense, investing US$ 2.6 million of its own funds to complement the US$ 2.1 million provided by the MLF. It designed its new facilities and layout for the extremely sensitive HFC-134a and cyclopentane technologies. As a result, Pars eliminated the use of 193 ODP tons and increased annual production by 20 per cent, achieving a design capacity of 195,000 units.

Similar interventions in the flexible foam sector introduced liquid carbon dioxide (LCD) blowing technology for the production of foam slabs in 10 projects in five countries [5-14]. International experts helped firms get licenses for the LCD technology, while undertaking production cost assessments and analyzing new product markets with the overall aim to optimise their production process. The installation of the equipment required training of operational and managerial personnel. Introducing LCD technology through these projects eliminated 1,740 ODP tons of ODS, increased production capacity on average by 15 to 20 per cent, and opened new domestic markets for soft- and low-density foams.

A main conversion technology transferred to aerosol producers in the course of other MLF projects was based on the replacement of CFC propellants with hydrocarbon aerosol propellants (HAPs). In a few cases, the selected CFC replacement technology combined conversion of plants to both HAP and non-flammable HFC-134a (the latter was used for pharmaceutical products). The conversion process in one case brought about a significant increase in production (factor of three) [15], and in another case allowed a company to correct its declining sales of CFC-based aerosols against cheaper hydrocarbon-base equivalents [16]. In most cases, as illustrated by [17], the conversion of an aerosol plant to

[9] Reorganization and rationalization has occurred in plant level conversions undertaken by all three implementing agencies. “A number of companies took advantage of grant funding being available to realize a plant modernization and to achieve technological upgrading and in several cases an increase of production capacity as well”. (UNEP, 2001a, p13).

HAP-based technology involved reformulation of the aerosol product composition, which allowed the project beneficiary to maintain or improve the quality of its products.

Other productivity benefits, as suggested above, flowed from production and product changes associated with the phase-out of CFCs. Some factories improved the quality of their products on their own initiative. For example, Chinese and Iranian engineers, assisted by an Italian engineering firm and a Hungarian compressor manufacturer, redesigned their traditional CFC-12 compressors to handle ODS-free (isobutane and HFC-134a) refrigerants, also reducing noise and vibrations and improving energy efficiency [18-19]. Through design modifications that not only met the latest international standards but also consumer requirements, the compressor factories could be certified to ISO 9000. At a consequence, their customers, refrigerator manufacturers, were able to upgrade their products using up-to-date compressors, further adding to the emerging marketing advantage.

Achieving productivity and quality improvements, however, has not occurred easily in other cases.[10] Firms that manufacture flexible foams for the furniture and automotive industries have initially encountered difficulties in improving their performance parameters and quality of products to international standards [12 and 20]. Similar difficulties were encountered in ODS phase out projects for packaging and exporting agricultural products from China. In this case the few large firms that emerged from the consolidation of several smaller firms needed time to absorb and make operational the new hydrocarbon technology [21]. Lastly, convincing the growers of strawberries in Morocco to phase out methyl bromide was not an easy task. Project implementation in this case required that agents emphasize practical results; they had to develop a special demonstration project that used viable and appropriate technologies successfully [22].

In the long run, ODS-free products, along with better design and improved quality of products, helped many firms improve their market access by increasing export potential. Among Chinese manufacturers, Aucma increased its export of deep freezers from a few thousand units in 1995 to 170,000 units in 2001 as a result of implementing an MLF project. This firm was able to sign an agreement with General Electric to export 500,000 freezers under the General Electric label, specifically because its freezers were ODS free and met energy efficiency standards [23]. In Syria the Al Hafez Company improved the quality and energy efficiency of its newly designed ODS-free models of refrigerators at its own expense. As a result, it has not only been able to maintain its leading market position domestically (40 per cent share), but in the meantime now exports 20 per cent of its ODS-free refrigerators to neighbouring countries [24].

5. Productive Employment

MLF projects have contributed in many circumstances to the potential for industry to sustain and even create productive jobs; other times they have reduced employment opportunities. In most cases, one might reasonably predict, they contribute to sustaining long-term employment because rapidly increasing market prices for CFCs (prices of CFCs have already increased on average from US$ 2/kg to US$ 4-6/kg) and declining CFC production in Article 5 countries will force many firms to cease production by the phase out deadline for developing countries of 2010.

[10] Implementation delays are regularly discussed at meetings of the Executive Committee of the MLF. The latest report is entitled ‘Project Implementation Delays’ (UNEP, 2004f). The MLF evaluation of 19 refrigeration projects states “that several companies faced great difficulties at the beginning of the conversion, especially in competing with lower priced CFC refrigerators still being produced or imported into the same country” (UNEP/MLF, 1999, 17).

The 41 UNIDO manufacturing investment projects covered in this review assisted 516 enterprises with approximately 12,000 employees (see Annex Table 1). Approximately three quarters of these were classified as small and medium sized enterprises (SMEs) by their governments. (make into footnote Unfortunately. MLF investment funds have not been available to all SMEs using ODS. These SMEs, particularly the small solvent and foam users, will experience economic hardships with the increasing costs for CFCs in coming years.)

Some of the conversion projects increased the number of employees—additional labour being needed to meet increased product demand. The conversion process at a foam manufacturing enterprise involved adding a new production facility, which increased the number of employees by about 50 per cent [9]. Other conversion projects have enabled local manufacturers, in Turkey and Egypt for example, to survive in an increasingly competitive market, thus ensuring job continuation [5 and 25]. Yet others have mitigated to some extent job losses in production processes by adding new employees to meet safety requirements; this happened to foam packaging operations in China [26]. In yet other cases, a number of enterprises experienced financial difficulties or even closed as a result of the conversion process. For example, a few enterprises in the aerosol sector faced bankruptcy or distress sale because they had not managed the conversion process well; others now operate only one to four
months a year (UNEP/MLF, 2002). In China, some conversions involved
re-organization and industrial rationalization that resulted in an about 50 per cent reduction in the number of jobs associated with small family enterprises. In that situation, the Chinese State Environmental Protection Agency required the bigger enterprises to take measures to minimize social impacts and to some extent the job losses were offset by new maintenance and logistic jobs at the larger centralized production units [21].

Projects generated and sustained employment in non-manufacturing sectors as well. National Refrigerant Management Plans (RMPs), for example, train workers to service or maintain refrigeration and air-conditioning equipment. Romania's RMP provided around 300 licensed refrigeration service workshops, updating service technology information and also upgrading service equipment [27].

In terms of sustaining employment, those projects that substitute methyl bromide in pre-planting soil fumigation have the greatest impact. In the case of one project in Morocco, 350 farmers producing strawberries switched to non-ODS alternatives, which should allow them to continue exporting to European markets after the ban on methyl bromide comes into effect in the EU in 2006 [22]. This kind of work is now being applied to other agricultural fields, such as the cutting of flowers in Uganda and Zimbabwe [28 and 29].

At the core of sustained productive employment are managers and technicians with sufficient skills to absorb and adapt new technical information. A key component of all MLF projects are therefore training programmes that enhance those skills. Installing state-of-the-art non-ODS technology also requires on-the-job and external training of operators and maintenance staff to ensure optimal performance of the new equipment. In the foam and refrigeration sectors, for example, newly introduced licensed equipment met the anticipated quality standards only because of the UNIDO projects required internal and external training.

The training provided under national RMPs is multifaceted. In addition to establishing or upgrading national training centres, RMPs facilitate the training and certification of service technicians and aim at best maintenance practices. They establish recycling centres supporting service technicians, provide recovery equipment and trained personnel, and set up performance monitoring systems for the national ozone office. Over a period of two years, the UNIDO RMP programmes for Central and Eastern Europe certified 300 technicians in Romania, 530 in Croatia, and 230 in Macedonia [27,30 and 31].

An essential aspect of training concerns safe handling of new equipment and chemicals. Nowhere is that more necessary than in conversion processes to hydrocarbons, which are flammable. The whole production cycle (storage, handling, and transport of hydrocarbons within the plant, processing and charging the mixtures containing hydrocarbons into the appliances) has to be a safe system. UNIDO's MLF projects address these concerns by insisting that foaming and refrigeration equipment suppliers must work closely with Germany's technical safety institution, TÜV, throughout the design, manufacturing, commissioning, and start-up phases. Suppliers must prepare safety plans with the recipient companies and local safety authorities. One of the major components of these safety plans is the training of plant technicians and operators in safe material handling, processing, and maintenance. In some cases, for example in Egypt, the necessary safety practices were not immediately followed, however, and additional training was needed to ensure safe operations [32] (UNEP/MLF, 1999). Similar safety concerns and training issues are addressed in phasing out CFC-based solvents and aerosols.

Not only has there been a direct creation of employment and training in factories, but also secondary employment generation as found in the implementation of the RMP in Romania [27]. A local industry had an opportunity to produce refrigerant recovery machines and the countrywide system for refrigerant recycling gave local firms another business opportunity. In some situations, MLF projects have required subcontracting of various supplies and services to local firms, for such items as tanks for hazardous chemicals, ventilation systems, and even foaming machines [8 and 13].

6. Cross-sectoral issues

Some of the significant impacts of MLF projects have been indirect, falling outside the three Es of sustainable industrial development—environment, economy, and employment. However, these contributions, often the building blocks for sustainable industrial development, are important and need to be recognized, particularly as they support the growth of small and medium size enterprises (SMEs). They are best summarized as technology transfer and building human capability (skills).

6.1 Technology Transfer

Some UNIDO MLF projects have transferred the latest non-ODS technologies to developing countries—in some cases spearheading their development. Technology is most commonly defined as a set of knowledge contained in ideas, information, or data of technical relevance; it includes personnel technical skills and expertise and equipment, as well as prototypes, designs, and computer codes (Gee, 1993). Transfer of technology therefore can appear in any of the above forms or their combinations, some embodied in the equipment supplied, while others take the forms of expertise, training, and software. The following examples all refer to the transfer of technology from industrialized countries to developing countries, aiming to reduce the use of ODS in manufacturing processes and agricultural activities.

Refrigeration — Recognizing the emerging use of hydrocarbon technologies as foaming and cooling agents, the MLF Executive Committee approved in 1995 two fully hydrocarbon (cyclopentane and isobutane) domestic refrigeration projects in China [18 and 19]. In addition it approved two projects for the conversion of Chinese compressor manufactures to isobutane in the same year [33 and 34]. These four funded projects imported components from Denmark, Germany, and Italy.

Urethane foam processing — The MLF Executive Committee approved in 1997 liquefied carbon dioxide (LCD) blowing technology as an alternative solution for flexible polyurethane foams, emphasizing the minimal GWP of the new technology. This approval also enabled international experts and owners of patents for this technology in Italy and the United Kingdom to provide guidance on how to license the technology as part of investment projects [35 and 36].

Solvents – The MLF Executive Committee in 1994 allowed the use of hydrocarbons in the closed-cycle cleaning of electronics assemblies. The first such UNIDO investment projects were in the electronics industry of India and soon after of Egypt, based on technologies imported from Germany and the Netherlands [37 and 38].

Process agents – The MLF Executive Committee in 2000 approved projects for the phase out of carbon tetrachloride (CTC) as a process agent in the ibuprofen, bromhexane, and diclophenac sub-sectors of the pharmaceutical sectors of India and Pakistan, based on technologies licensed from Germany and manufactured in India and China [39 and 40]. The MLF Executive Committee also encourages CTC phase out in the manufacture of intermediates and auxiliaries for other pharmaceuticals and agrochemical compounds, based on imported technology licenses.

Fumigants – One UNIDO MLF project offered alternative technologies available from several European countries (primarily The Netherlands, Spain, and France) to replace methyl bromide for soil and storage fumigation [22]. The task was complex as there is no single alternative fumigant. Parameters and operations had to be adapted to the locally used crops, and some variations were necessary because of specific climate and soil conditions. Local experts conducted demonstration projects guided by international experts.

Most ozone-friendly technology transfer, such as that described above, has taken place between developed and developing countries. However, there are some remarkable exceptions: a Lebanese firm provided the engineering drawings and components for refrigerator manufacturing in Nigeria [41], and a Hungarian firm supplied the compressor design and technology to enterprises in China and Iran [3-4]. In the methyl bromide sector, experts from Colombia—a leader in exporting cut flowers that is not using methyl bromide in soil fumigation—advised other countries, such as Uganda and Zimbabwe, on alternative soil fumigation programmes [28 and 29].

Secondary technology transfer—namely, the acquisition of new skills for local production and installation of equipment that is essential to a conversion project— has occurred in some cases [4, 42, 43, and 44]. These projects upgraded local skills, to supply new types of products like storage tanks for hazardous chemicals, production equipment, and components that meet international standards. Under the supervision of international equipment suppliers, they also up-graded skills needed to install equipment.

6.2 Plant-level capability building

Successful transfer of ODS phase-out technologies, as stated in the definition of technology transfer in the previous section, depends on building essential skills. These key skills include enhanced project design, production engineering, equipment maintenance, and repair skills.

Redesign of the first batch of ozone-friendly freezers at the XingXing Group in China required the assistance of a refrigeration institute from the United Kingdom, for example [45]. It was a joint effort between the enterprise and the institute that trained the company engineers, so XingXing was finally able to undertake the conversion of remaining models on its own. This project also trained operators and maintenance staff in best techniques for operating and up-to-date safety practices, which were then applied throughout the entire production process.[11] Several enterprises in Indonesia and Turkey in the automotive, furniture, and shoe sectors similarly learned how to formulate chemical compounds in order to phase out ODS. Based on the skills acquired in chemical formulation, they were subsequently able to design and introduce new models of moulded and integral skin foams into their production programmes [35, 36, 46].

In other cases, particularly in projects requiring rationalizing and consolidating production processes as it was the case in China, the building of plant-level capacity building has been even more extensive. The process combined reductions and relocations in 52 enterprises with 171 production lines, aiming to eliminate the use of ODS entirely [21 and 26]. At the end of the conversion process, only 20 enterprises with 84 converted or new production lines for manufacturing extruded polystyrene and polyethylene packaging foams for fast food and agricultural products remained in operation. All remaining enterprises have improved their technical, commercial, and managerial skills, thereby enhancing their chance for long-term financial survival [21 and 26].

6.3 Building national capabilities

Whilst the thrust of the MLF programme is plant-level phase-out of ODS, the MLF technical assistance work also helps develop capabilities within public and private sector institutions by improving their managerial responsibility skills and the ways in which they deliver services to industry.

At the country level, it has been essential to create and support national ozone units, which are usually but not always, affiliated with national environmental protection agencies. It is these units' responsibility to design, monitor, and implement the ODS phase-out Country Programmes and to select the enterprises requiring funding from the MLF. Such an organizational structure is a precondition for countries' access to MLF project financing [47-50].

MLF funded projects also support technical institutions that deal directly with enterprises. In one case, a project contracted an R and D centre in China to undertake the design work for switching to isobutane as a coolant for compressors [33]. In the Democratic People's Republic of Korea (North Korea), an equipment manufacturer became a service facility for solvent CTC phase-out for a number of factories in the metals and machinery sector [51]. In Romania, a refrigeration training centre became the core training centre for Romania's RMP [27].

Through their hiring of local experts to assist enterprises, MLF projects contribute to institutional capacity building even where there is no formalized arrangement with industrial service institutions. For example, a Chinese project, phasing ODS out of extruded foam production for packaging agricultural products, concentrated on 15 expanded and modernized factories. Each factory employed foam experts from the State Environmental Protection Agency as local consultants to advise on the use of the new technology. MLF support also ensured the Agency's capability to provide further services to the rigid insulation foams sector by sending the local experts to Germany for training in technical and commercial aspects of optimal formulation, distribution and application of new chemical components and blends [26].

[11] Another example of plant level capacity building resulting from an non-UNIDO MLF funded investment project, described in the MLF Evaluation of Compressor Projects in China, is that of Shanghai General Machinery Works. It has successfully developed a design for compressors to be used with CFC-22 and produces them in large numbers and at a cost lower than the ones based on imported design (UNEP, 2001b, p8).

7. Conclusions

UNIDO executed MLF projects have contributed as expected to the phasing out of ODS. Beyond that core aim of the Montreal Protocol, they have also contributed to other aspects and dimensions of sustainable development, however. These ‘side-effects’ were so far not given due consideration in the literature. This article, looking at 51 UNIDO projects from a broad perspective, has offered insights into the complex outcomes of projects under a highly specific environmental agenda. Unfortunately potentials to contribute to sustainable development without additional cost so far have been overlooked in some projects, but we suggest this can change if the potential multiple effects described in this paper get considered systematically in future project design. Recognizing these multifaceted realities and results might help the policy community to move towards a more integrated sustainable strategy and implementing practice and thereby make international environmental policy more effective.

This is a summary of our empirical findings. Several of the projects we reviewed reduced the potential for other environmental risks than ozone depletion; some increased the competitiveness of enterprises in domestic and international markets. Others sustained employment opportunities or improved working conditions (safety and health) and in a few cases created employment opportunities. In some cases associated training programmes contributed to strengthening of management and technical skills that help absorb and adopt new technologies. Others projects, fewer in number however, initially caused difficulties in maintaining the quality of products or reduced employment opportunities—this particularly happened in conversions that require the rationalizing of manufacturing processes.

In light of this, we asked ourselves why such multiple effects have not been addressed in a broader manner, giving credit to the full range of environmental, economic, and social implications of MLF funded investment projects. The lack of documentation is not surprising, however, for at least three reasons. First, evaluations of the impacts on sustainable development in individual conversion projects require considerable time and financial resources. Often such evaluations appear to be difficult to pursue because project completion reports are incomplete or key plant personnel involved in the conversion project are no longer associated with the enterprise.[12] Second, the Executive Committee of the MLF does not require its executing agencies for MLF funded investment projects to collect economic and social baseline information as a prerequisite for delivering investment funds for plant level conversions in developing countries. The Executive Committee calls only for information on ODS use by the manufacturer(s), on technology options, incremental investment and operating costs, and on the amount of ODS to be eliminated. Third, there is no project design guidance for the staffs of the implementing agencies that makes clear how associated benefits within the broad range of sustainable development can be maximized at no additional (incremental) expense to the MLF. So, whenever these other benefits result, and they often do, they happen mainly as a result of individual initiatives by staffs of the implementing agencies and enterprises concerned about their economic future.

Based on our analysis, we believe that the contributions from MLF investment projects to sustainable development could be significantly amplified with systematic

[12] According to the MLF evaluation of foam projects, consultants’ experience has shown that collecting project completion reports or related information is a time-consuming, difficult, and sometimes even impossible task, especially if the beneficiary company and the Implementing Agencies have not prepared the data at the time of project completion. In a number of cases, the company staff responsible for the conversion project had changed, the records of data, particularly with regard to production, operating cost (prices and volumes)and equipment cost, were not available. Many companies promise to prepare and send the missing information after visits, but this only occurred in one case (UNEP, 2001a, p21).

guidance for the technical staffs of the implementing agencies. Project design guidelines need to demand consideration of potential associated benefit, while ensuring that such benefits do not entail any additional cost to the MLF core-objective of phase-out ODS.

Having identified the potential for MLF funded projects to contribute systematically to national economic and social development plans and strategies, we suggest looking beyond the specific case of the Montreal Protocol and applying the insights of our paper to other international efforts that fund the mitigation of global environmental problems. Having the design of Global Environment Facility (GEF) industry-related projects in mind, we particularly envision the need for clear project design guidance on sustainable development in the focal areas of climate change, international waters, ozone depletion, and persistent organic pollutants (GEF, 2002). Furthermore, if the GEF supports capacity building for the Clean Development Mechanism of the Kyoto Protocol, there will be a need for supplemental guidance in this field too.[13] Many GEF projects in these focal areas indeed have the potential to generate multiple beneficial impacts in addition to their stated environmental objective. However, this potential will be realized only if the projects are designed and implemented in ways that integrate social and economic concerns into environmental mitigation efforts.

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[13] Article 12:2 of the Kyoto Protocol states that "the purpose of the clean development mechanism [to be funded by the GEF] shall be to assist Parties not included in Annex 1 [developing countries] in achieving sustainable development and in contributing to the ultimate objective of the Convention…"

References

Anderson, S. and K. Sarma (2002), *Protecting the Ozone Layer: The United Nations History,* London and Sterling VA: Earthscan and UNEP.

Biermann, F. and U. Simonis (1999), 'The Multilateral Ozone Fund: A case study on institutional learning' , *International journal of Social Economics*, **26**: 239-273.

Brown, E., H. Weiss and K. Jacobson (1999), 'Getting countries to comply with international environmental agreements', *Environment*, **41**: 16-32.

Climate Action Network-Europe (2002), 'Ozone and climate at a crossroads: the other double phase-out', (www. climnet.org) [06-10-04].

COWIconsult (1995), 'Study on the Financial Mechanism of the Montreal Protocol', Prepared for the UNEP Ozone Secretariat, Nairobi, Kenya.

French, H. (1997), 'Learning from the Ozone Experience', in L. Brown, C. Flavin, and H. French, eds., *In State of the World*, New York: W.W.Norton & Company.

Global Environment Facility (2002), 'Operational Strategy of the Global Environment Facility', Washington: Global Environment Facility. (www. gef.web.org) [05-08-04].

Gray, K. (2003), 'Multilateral Environmental Agreements in Africa: Efforts and Problems in Implementation', *International Environmental Agreements: Politics, Law and the Environment*, **3**: 97-135.

Gee, R. (1993), 'Technology transfer effectiveness in university-industry co-operative research', *International Journal of Technology Management*, **8**:652-658.

Intergovernmental Panel on Climate Change (2001), 'Climate Change 2001: The Scientific Basis', Contribution of Working Group I to the Third Assessment, www. grida.no/climate/ipcc_tar/ [08-10-04]

Oberthuer, S., S. Pfahl and J. Schemmel (2000), "Implementing the ODS Phase Out in Developing Countries: Lessons Learned from EU Experience', GTZ/Ecologic. www. gtz.de/proklima/english/publications. [08-10-04]

Obertuer, S. (2001), 'Linkages between the Montreal and Kyoto Protocols: Enhancing Synergies between Protecting the Ozone Layer and the Global Climate', *International Environmental Agreements: Politics, Law and the Environment*, **1**: 357-377.

O'Connor, D. (1991), 'Policy and Entrepreneurial Responses to the Montreal Protocol: Some Evidence from the Dynamic Asian Economies', Technical Paper No. 51, OECD Development Centre, Paris, OECD.

Parson, E. (2003), *Protecting the Ozone Layer: Science and Strategy*. Oxford: Oxford University Press.

UNEP (1995a), ‘1994 Report of the Methyl Bromide Technical Options Committee’, Seventh Session of the Meeting of Parties (www. unep.org/ozone). [08-10-04]

UNEP (1998), The Kyoto Protocol to the Convention on Climate Change, Text Available from the Climate Change Secretariat, Bonn Germany.

UNEP/MLF (1999), ‘Report on the Implementation of the 1999 Work Programme for Monitoring and Evaluation, Includes Evaluation of Refrigeration Projects’, UNEP/Ozl.Pro/ExCom/29/5/Add.1 (not available on-line; they must be requested from the Evaluation Unit, MLF).

UNEP/MLF (2000), ‘Revised Strategy and Guidelines For Projects in the Methyl Bromide Sector’, UNEP/Pzl.Pro/ExCom/32/44/ Annex 14.

UNEP/MLF (2001a), Final Report on the Evaluation of Foam Projects’, UNEP/Ozl.Pro/ExCom/33/6. (Evaluations are not available on-line; they must be requested from the Evaluation Unit, Executive Committee, MLF).

UNEP/MLF (2001b), ‘Evaluation of Completed Compressor Projects in China’, UNEP/Ozl.Pro/ExCom/34/17. (Evaluations are not available on-line; they must be requested from the Evaluation Unit, Executive Committee, MLF).

UNEP/MLF (2001c), ‘Final Report on the Evaluation of Solvent Projects’, UNEP/Ozl.Pro/ExCom/35/12. (Evaluations are not available on-line; they must be requested from the Evaluation Unit, Executive Committee, MLF).

UNEP/MLF (2002), ‘Final Report on the Evaluation of Aerosol Projects’, UNEP/Ozl.Pro/ExCom/38/5. (Evaluations are not available on-line for external parties; they must be requested from the Evaluation Unit, Executive Committee, MLF).

UNEP (2003), ‘Report of the Executive Committee to the Fifteenth Meeting of the Parties’, UNEP/Ozl.Pro.15.8.

UNEP/MLF (2004a) ‘Progress Report 2003 for UNDP’, UNEP/Ozl.Pro/ExCom/43/12.

UNEP/MLF (2004b), ‘Progress Report 2003 for UNEP’, UNEP/Ozl.Pro/ExCom/43/13.

UNEP/MLF (2004c), ‘Progress Report 2003 for UNIDO’, UNEP/Ozl.Pro/ExCom/43/14.

UNEP/MLF (2004d), ‘Progress Report 2003 for World Bank’, UNEP/Ozl.Pro/ExCom/43/15.

UNEP/MLF (2004e), ‘2003 Accounts’, UNEP/Ozl.Pro/ExCom/43/53.

UNEP/MLF (2004f) ‘Project Implementation Delays, Forty-Third Meeting of the Executive Committee’, UNEP/OzL.Pro/ExCom/43/17.

UNEP Ozone Secretariat (2004), 'Information Provided by the Parties in accordance with Article 7 of the Montreal Protocol on Substances that Deplete the Ozone Layer', Implementation Committee under the Non-Compliance Procedure for the Montreal Protocol, Geneva 17-19 July 2003, UNEP/OzL.Pro/ImpCom/32/3.

UN Framework Convention on Climate Change (1998), 'Review of the Commitments and Other Provisions of the Convention', FCCC/CP/1998/ INF. 9. (www. unfccc.int/resources). [08-10-04]

UNIDO (1998), 'Sustainable Industrial Development: UNIDO's Definition', Vienna: UNIDO. (www .unido.org/wssd/publications/wssd). [08-10-04]

UNIDO (2002), Ozone Friendly Industrial Development: 10 Years of UNIDO in the Montreal Protocol, Vienna, Austria, V.02-55504. (www. unido.org).

UNIDO, 2003. Ozone Friendly Industrial Development: Impact and Lessons Learned, Six volumes—overview, refrigeration and alternative technologies for domestic appliances, plastic foams, solvents (including process agents) and aersols, fumigants and refrigeration management plans. Vienna. Austria, V.03.89091-6.

U.S. Environmental Protection Agency, 1996. Class I Ozone-Depleting Substances, (www.epa.gov/ozone/ods).[07-10-04]

U.S. Environmental Protection Agency, 2000. Global Warming Site—International Emissions, (www. epa.gov/globalwarming). [07-10-04]

World Bank (2004), 'World Bank's Approach to Global Programs: Phase 2 Report', Case Study: The Multilateral Fund for the Implementation of the Montreal Protocol. Washington: World Bank.

Zhao, J. and L. Ortolano (1999), ' Implementing the Montreal Protocol in China: Use of Cleaner Technology in Two Industrial Sectors', *Environmental Impact Assessment Review,* **19**: 499-519.

Table 1. Multilateral Fund Expenditure and Ozone Depletion Potential Reduced by Implementing Agency (As of December 2003)

Agency	Expenditure of MLF[1] (US$ million)	ODP Consumption and Production Eliminated ODP tons[2]
UNDP	332.1	38,400
UNEP	63.8	200
UNIDO	295.8	30,700
World Bank	526.9	117,700
Sum	**1,218.6**	**187,000**

1.This allocation includes agency support cost.

2. Less than 1,000 ODP tons eliminated by the collective funding of France, Germany, USA and UNEP.

Source: UNEP/MLF, 2004 a-e

Table 2. Overview of UNIDO project implementation, 1992-2004.

Sector	Number of Projects Approved mid 2004, (only Investment)	Number of Projects Included in This Review	US$ Amount Disbursed mid 2004 (10^6)	US$ Amount of Projects Reviewed (10^6)	ODS Phased Out By mid 2004 (10^3)	ODS Phased Out by Projects In Review (10^3)
Refrigeration	352/(199)	(12)	133.6	24.6	12.2	3.0
Plastic Foam	186/(125)	(19)	54.5	22.6	10.6	4.5
Solvents & Process Agents	96/(68)	(7)	13.9	2.8	1.3	0.4
Fumigants and tobacco	127/(30)	(3)	28.3	3.3	1.3	0.3
Refrigeration Management Plans (part of ref.)	50/-	3	4.5	0.8	0.4	0.1
Aerosols	62/(44)	(3)	7.8	1.0	3.4	0.3
Halons	9/(6)		0.8		1.5	
Production Sector	5/(4)		17.0		0	
Support for National Ozone Institutions	68/-	4	4.4	0.6	0	0
Other	26/(13)		1.6		0	
TOTAL	**931/(484)**	**51**	**266.4**	**55.7**	**30.7**	**8.5**

Source: UNIDO (2004)

Table 3: Change in ODP and GWP based on approved UNIDP projects as 2004

Sector	**CFC 11 / ODS Phase Out (tons)**	**CFC 11 / ODP Phase Out (tons)**	**GWP (million tons CE)[1]**	**Substitute Phase In (tons)**		**ODP[2] (tons)**	**GWP (million tons CE)**
Foam Sector							
	4,600	4,600	28.8	Butane	2,200	NO	NO
	2,000	2,000	13	Carbon Dioxide	800	NO	NO
	100	100	0.7	Cyclopentane	80	NO	NO
	2,900	2,900	18.3	HCFC - 141b	2,600	300	5.5
	200	200	1.2	HCFC - mix	200	20	0.3
	1,800	1,800	11.3	Pentane	1,400	NO	NO
	300	300	2	Water & Carbon Dioxide	300	NO	NO
Sub-Total	12,000	12,000	75.3	Sub-Total	7,500	320	5.8
Sector	**CFC 12 / ODS Phase Out**	**CFC 12 / ODP Phase Out**	**GWP (million tons CE)**	**Substitute Phase In**		**ODP**	**GWP (million tons CE)**
Refrigeration Sector							
	8,000	8,000	81.9	Cyclopentane	6,400	NO	NO
	2,000	2,000	20	HCFC - 141b	1,700	200	3.7
	30	30	0.3	HCFC - 22	30	1	0.2
	2,400	2,400	24	HFC - 134a	2,100	NO	7
	700	700	6.9	Isobutane	300	NO	NO
Sub-Total	13,000	13,000	133	Sub-Total	10,500	200	10.9
Total	25,000	25,000	208	Total	18,000	500	16.7

1.GWP of CFC 11 is 6,300; GWP of CPC 12 is 10,200: GWP of HCFC 141b and mix is 2,100; and GWP of HFC 134a is 3,300
2. ODP of HCFC 141a and mix is 11 percent total substance; ODP of HCFC 22 is 5 percent of total substance

Source: MFL Secretariat for ODP phased out and amount of substitute phase in. UNIDO calculation of change in GWP.

Annex Table 1 List of Projects Examined for Sustainable Development Implications

Nr.For Article	Name of Project	Project Number	US$ Amount	ODP Tons Phased Out	Number of plants	Employees
1	Conversion of metal cleaning processes from TCA solvent to TCE degreasing at Maasara Co. for engineering industries	EGY/SOL/31/INV/80	294,925	10.7	1	300
2	Conversion of carbon tetrachloride as process agent to cyclohexane at Amoli Organics Ltd., Mumbai	IND/PAG/35/INV/338	385,367	38.5	1	6
3	Phasing out ODS at Hangzhou Huari Refrigerator Co.	CPR/REF/18/INV/147	2,809,566	338	1	1530
4	Conversion of domestic refrigerator production facilities to phase out CFC-12 and CFC-11 (2nd group) at Pars Machine Manufacturing Co.	IRA/REF/18/INV/13	608,605	62	1	700
5	Phasing out of CFC-11 at Urosan Kimiya Sanayii A.S.	TUR/FOA/20/INV/22	631,542	135	1	45
6	Phasing out CFC-11 at Isbir Termoset Plastic San. A.S., Ankara, Turkey	TUR/FOA/23/INV/30	501,011	130	1	27
7	Phasing out of CFC-11 from flexible slabstock foam manufacturing at Urethane Systems Company (USC)	IRA/FOA/22/INV/21	481,670	110	1	15
8	Phasing out of CFC-11 from flexible slabstock foam manufacturing at Mashhad Foam	IRA/FOA/23/INV/29	503,330	90	1	18
9	Investment project for phasing out CFCs at Krayem Cold Stores Co.	SYR/FOA/19/INV/15	634,365	65	1	30
10	Phasing out CFC-11 in manufacturing of flexible PU slabstock foam through the use of CO2 blowing technology at National Polyurethane Company (N.P.C.)	SYR/FOA/26/INV/32	543,891	96	1	15
11	Phasing out CFC-11 at Sonopol	CMR/FOA/23/INV/11	506,075	130	1	12

12	Phasing out CFC-11 at Scimpos	CMR/FOA/23/INV/10	540,002	120	1	9
13	Phasing out CFC-11 at Sud Inter Mousse flexible polyurethane foam plant	TUN/FOA/23/INV/23	545,782	102	1	12
14	Phasing out CFC-11 in manufacturing of flexible polyurethane slabstock foam through the use of liquid CO2 blowing technology at Espol Sunger Company	TUR/FOA/31/INV/68	552,297	95	1	10
15	Phasing out of CFCs at Entreprise Nationale des Detergents (ENAD)	ALG/ARS/18/INV/12	614,499	150	1	150
16	Phasing out of CFCs at Vague de Fraicheur	ALG/ARS/20/INV/16	164,522	51.4	1	32
17	Investment project for phasing out of CFCs at Cosmaline Industries s.a.al.	LEB/ARS/19/INV/05	212,500	87.7	1	6
18	Conversion of domestic refrigerator and freezer factories to phase out CFC-12 and CFC-11 by hydrocarbon isobutane and cyclopentane at Hangzhou Xiling Holdings Co.	CPR/REF/17/INV/119	2,790,320	360	1	900
19	Conversion from CFC-11 to HCFC-141b and CFC-12 to HFC-134a technology in the manufacture of domestic and commercial refrigeration equipment at the Novin Enjemad	IRA/REF/34/INV/105	138,702	10.1	1	45
20	Phasing out CFC-11 by conversion to water system as a blowing agent in the manufacture of flexible polyurethane foams at Manufacturas Enveta, C.A. Cumana	VEN/FOA/36/INV/94	198,882	32	1	8
21	Elimination of CFC-12 in manufacturing of EPE foam packaging nets at 27 enterprises (Umbrella Project)	CPR/FOA/28/INV/301	5,287,745	825.7	27	130
22	MeBr phase out - soil fumigation in strawberry production	MOR/FUM/32/INV/41	2,189,729	155		-

23	Phasing out ODS at the refrigerator plant of Aucma Electric Appliances Group Co.	CPR/REF/20/INV/173	2,913,427	708	1	512
24	Phasing out of CFCs at Al Hafez Refrigeration Co.	SYR/REF/13/INV/04	2,883,277	106.7	1	200
25	Phasing out ODS at the Kiriazi Refrigerators Manufactruing Co.	EGY/REF/13/INV/35	1,587,585	137	1	600
26	Elimination of CFC-12 in manufacturing of EPE foam packaging nets at 25 enterprises (umbrella project)	CPR/FOA/25/INV/04	4,485,892	1,146.00	25	120
27	Refrigerant management plan: recovery and recycling	ROM/REF/28/TAS/16	373,309	50	312	1050
28	Phase-out of methyl bromide in cut flowers	UGA/FUM/34/INV/08	228,800	12	-	-
29	Phase-out of methyl bromide in cut flowers	ZIM/FUM/31/INV/21	904,200	132	-	-
30	Refrigerant management plan: national recovery and recycling project	CRO/REF/28/TAS/10	285,717	15	38	120
31	Refrigerant management plan: recovery and recycling	MDN/REF/28/TAS/10	176,103	13.5	53	150
32	Phasing out ODS at Helwan Company for Metallic Appliances domestic refrigeration plant	EGY/REF/15/INV/38	613,845	7.5	1	200
33	Replacement of CFC-11 and CFC-12 with cyclopentane and HFC-134a in the production of refrigerators at Banshen Electric Appliances Co.	CPR/REF/31/INV/357	2,392,316	211.9	1	362
34	Replacement of CFC-11 and CFC-12 with cyclopentane and isobutane in the production of refrigerators at Little Swan Electric (Jingzhou) Co. Ltd.	CPR/REF/32/INV/365	3,400,000	600	1	380

35	Phase-out of CFC-11 consumption by conversion to water-blown technology and HCFC-141b at P.T. Meta Presindo Utama in the manufacture of polyurethane integral skin and moulded polyurethane foam	IDS/FOA/29/INV/113	213,485	21.8	1	12
36	Phase-out of CFC-11 consumption by conversion to water-blown technology and HCFC-141b at P.T. Nirwana in the manufacture of polyurethane integral skin and flexible moulded polyurethane foam	IDS/FOA/29/INV/110	206,703	32.6	1	10
37	Conversion of electronic cleaning processes from ODS solvents aqueous cleaning at ITI Mankapur	IND/SOL/13/INV/25	610,147	34	1	500
38	Conversion of electronic cleaning processes from ODS solvents to non-ODS cleaning at 3 electronic companies	EGY/SOL/18/INV/52	227,203	13.7	3	350
39	Conversion of carbon tetrachloride (CTC) as process solvent to ethylene dichloride at Satya Deeptha Pharmaceuticals Ltd., Humnabad	IND/PAG/32/INV/287	260,133	27.9	1	50
40	Conversion of carbon tetrachloride as process solvent to 1,2-dichloroethane at Himont Chemicals Ltd.	PAK/PAG/35/INV/42	485,701	80	1	9
41	Phasing out of CFCs at Thermocool Eng. Co. Ltd.	NIR/REF/18/INV/11	1,465,679	82	1	600
42	Phase out of CFC-12 in the manufacture of extruded polystyrene foams to butane at 9 enterprises (umbrella)	CPR/FOA/34/INV/376	2,808,338	750	9	200

43	Phasing out CFC-11 with HCFC-141b at six companies Hongyu, Longan, Songliao, Tianyun, Xinyang and Yizheng) and phasing out CFC-11 by conversion to water blown technology at one company (Yinxian)	CPR/FOA/34/INV/375	1,087,764	191.6	7	63
44	Phase out of CFC-12 in the manufacturing of extruded polystyrene foams through the use of butane as a blowing agent at 7 enterprises (terminal umbrella project)	CPR/FOA/35/INV/379	2,450,123	359	7	70
45	Phasing out ODS at the freezer plant of Xing Xing Electric Appliances Industrial Co.	CPR/REF/23/INV/223	3,007,728	348	1	2080
46	Phasing out of CFC-11 in manufacturing of flexible polyurethane slabstock foam through the use of CO2 blowing technology at Serra Sunger	TUR/FOA/25/INV/47	454,236	86	1	12
47	Establishment of an Ozone Unit	BHE/SEV/27/INS/02	110,000	-	N.A.	N.A.
48	Creation of the National Ozone Unit	LIB/SEV/32/INS/04	157,000	-	N.A.	N.A.
49	Creation of an Ozone Secretariat	ROM/SEV/17/INS/04	168,443	-	N.A.	N.A.
50	Creation of Ozone Secretariat	YUG/SEV/25/INS/07	151,500	-	N.A.	N.A.
51	Conversion of remaining metal cleaning processes from ODS solvents to vapour degreasing at Unsan Tools Factory (UTF)	DRK/SOL/26/INV/11	487,186	168	1	300
	TOTAL		**55,731,167**	**8,528**	**516**	**11,950**

1.The project number is the identifier that both UNIDO and the MLF Secretariat use to identify a project. Each number begins with a country identifier, sector, and MLF session that approved project, type of project, and number of project in the country. The abbreviations for sectors are as follows: aerosols (ARS), forms (FOA), fumigants (FUM), process agents (PAG), several (SEV) and refrigerants (REF). The abbreviations for project types are institutional strengthening (INS), investment (INV) and technical assistance (TAS).

Source: UNIDO (2004)