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Ozone-friendly Industrial development

**UNIDO in the Montreal Protocol
- technology transfer to developing countries**

**Impact and lessons learned—
Overview**



**UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna, 2003**

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First published 2003.

United Nations Industrial Development Organization, Programme Development and
Technical Cooperation Division, Multilateral Environmental Agreements Branch
Vienna International Centre
P.O. Box 300, A-1400 Vienna, Austria.
Tel.: +43 1 260 26-0; fax: +43 1 260 26-6804; internet: <http://www.unido.org>

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All tons are metric and all dollars are U.S. dollars.

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About this series

This booklet introduces a series of six, designed for specialists interested in the effectiveness and efficiency of UNIDO's sectoral programmes for phasing out the use of ozone depleting substances (ODSs) by industry and agriculture. Covering refrigeration and alternative technologies for domestic appliances, refrigerant management plans, plastics foams, solvents (including process agents and aerosols) and fumigants, they focus on the complex interventions required to replace technologies, equipment and operating procedures in the main ODS-consuming sectors. Each sector calls for a different set of technical, economic and (in some cases) social solutions. Case study presentations show that the common benefit of adopting ozone-friendly technologies is the opportunity to improve productivity, product design and quality and to move into new markets. The series documents not only the implementation of cost-effective projects, but also the many indirect benefits of UNIDO's work - such as technology transfer, employment generation, support for SMEs and institutional capacity building.

This introductory volume also places UNIDO's efforts as an implementing agency for the Multilateral Fund (MLF) of the Montreal Protocol in the context of UNIDO's mission to support developing countries and countries in transition in their pursuit of sustainable industrial development. UNIDO interprets such development as the accomplishment of three things: (i) protecting the environment - with industry complying with environmental norms, efficiently utilizing non-renewable resources and conserving renewable resources; (ii) encouraging a competitive economy - with industry producing for export as well as domestic markets; and (iii) creating productive employment - with industry promoting long-term employment and increased prosperity.

Abbreviations

CFC	chlorofluorocarbon
HCFC	hydrochlorofluorocarbon
HFC	hydrofluorocarbon
LCD	liquid carbon dioxide
ODS	ozone-depleting substance
ODP	ozone-depleting potential

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FOREWORD

The year 2002 has seen a milestone in UNIDO's contribution to preserving the stratospheric umbrella that protects life on earth from the sun's radiation - the ozone layer. Eleven years ago in October, the Organization became an implementing agency to the Montreal Protocol. It accepted, thereby, the challenge of helping cut back the use of ozone depleting substances (ODSs) that threaten the future of all life forms on our planet.



In that short interval since UNIDO became an implementing agency for the Montreal Protocol's Multilateral Fund, the Organization successfully eliminated an annual consumption of more than 24,500 tons of industrial chemicals that would otherwise have torn an even larger hole in the protective ozone shield. The allocation of 25 per cent of the Multilateral Fund's resources to UNIDO, increasing, as of 2003, thanks to the strong portfolio of projects, is unequivocal recognition of the Organization's track record in tackling the industrial challenges of today's world.

Working closely with the Fund's Secretariat and the United Nations Environment Programme, UNIDO applies its expertise in industry to transferring technology and know-how so that ODS consumption and its ozone depleting potential are reduced. Their impact has far exceeded the limited staff resources available within the Organization. A major success factor has been the establishment of an organizational branch dedicated to Montreal Protocol activities, which I created when transforming UNIDO in 1998.

Since then, UNIDO's role in combating ozone depletion has gone from strength to strength. But it has also taken on a new dimension, namely to help developing countries to benefit from globalization through increased trade. By enabling their industries to comply with environmental export requirements, UNIDO has opened up new markets for their industrial goods thus encouraging the growth of selected manufacturing sectors. The cooperation between UNIDO, the Multilateral Fund, other international agencies, donors and ODS technology recipients in pursuing the goals of the Montreal Protocol, demonstrates that collective multilateral efforts can indeed have a substantial impact on threats - environmental, economic and others - that face mankind.

Meanwhile the task of eliminating ODSs from industry is far from finished. To meet the challenges ahead, UNIDO is expanding its support for Montreal Protocol activities. In addition to individual projects to transfer ozone-friendly technologies, UNIDO will help developing countries plan their own phase-out programmes for ODSs. This summary booklet and its accompanying technical reports are an insight into one of the key value-added services that UNIDO offers its clients. They are also an industrial blueprint for protecting the ozone layer in the twenty-first century.

Carlos Magariños
Director-General

Overview

More than 150 countries have signed the Montreal Protocol. A landmark agreement to restore and protect the Earth's deteriorating stratospheric ozone layer, its implementation is essential for the health and survival of life on this planet. In order for this world-wide effort to succeed, both developed and developing countries must eliminate atmospheric emissions containing ozone depleting substances (ODS). The main materials are chlorofluorocarbons (CFCs) and other chlorinated and brominated compounds used in refrigeration, plastic foams, solvents, fumigants and aerosols. The magnitude and complexity of the task, in terms of planning, logistics, skills and implementation, can be seen from the tens of thousands of enterprises in many different industrial sectors in almost every country that must accept new technologies, install them and use them properly in the long term. However, enterprises in developing countries lack the resources to acquire and produce the new technologies. Nor has the international market place been particularly successful in transferring these technologies to them.

The Multilateral Fund of the Montreal Protocol (MLF) was set up to bridge the gap with financial support for international technology transfer programmes to help eliminate ODS emissions. The Fund's resources enable UNIDO and other MLF implementing agencies to offer policy advice, institutional strengthening, awareness raising, investment projects, feasibility and preparatory assistance studies and training and demonstration projects. The sectors addressed by UNIDO include refrigeration, fumigants (methyl bromide), foams, solvents (including process agents), aerosols and halons.

MLF implementing agencies chart their progress by the amount of *ozone depleting potential* (ODP) that their projects remove. In the ten years that UNIDO has been such an agency, its efforts in various sectors have cumulatively eliminated 24,500 ODP tons of annual ODS consumption from Article 5 countries (see fig. 1) - approximately 14 per cent of the total ODP tonnage eliminated at the end of 2002 by all the MLF agencies together.

Regionally, the ODP phased-out by UNIDO over the period 1992-2002 was: 66 per cent in Asia, 18 per cent in Africa, 10 per cent in Central and Eastern Europe (countries in transition) and 6 per cent in Latin America (see figs. 2 and 3). UNIDO's impact (fig. 4) has been greatest in the refrigeration sector - 42 per cent of the total amount phased out through MLF projects. This was followed by plastic foams (32 per cent), aerosols (13 per cent), halons (6 per cent), solvents (4 per cent) and fumigants (2 per cent).

Table 1 Ozone Depleting Potential Phased out by Region UNIDO MLF projects 1992-2002 (tons CFC-12 equivalent)	
Region	
Africa	4, 298
Asia and Pacific	15, 941 plus 500 (production)
Europe	2, 355
Latin America	1, 472
Total	24, 565

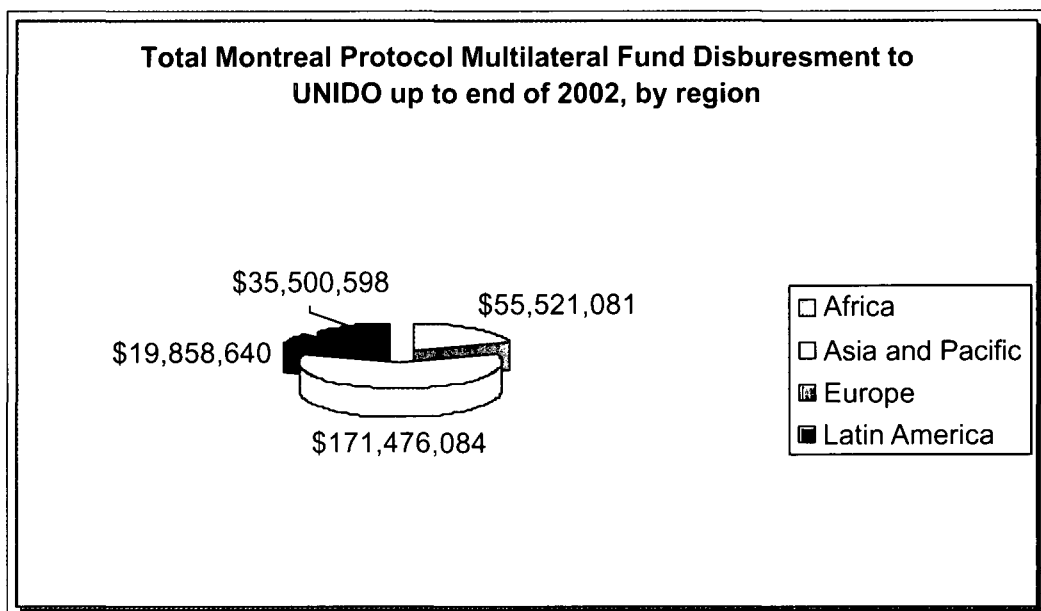


Fig. 2: Total Montreal Protocol Multilateral Fund disbursements to UNIDO up to end of 2002, by region

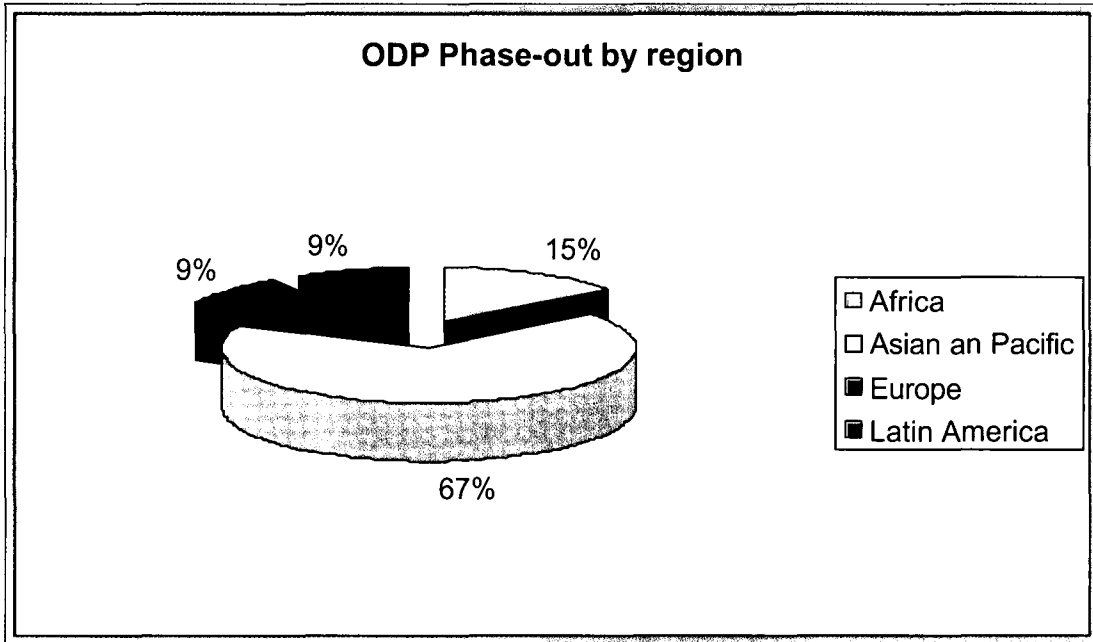


Fig. 3: Distribution of ODP phase-out:
By region by end 2002 (tons of CFC-12 equivalent)

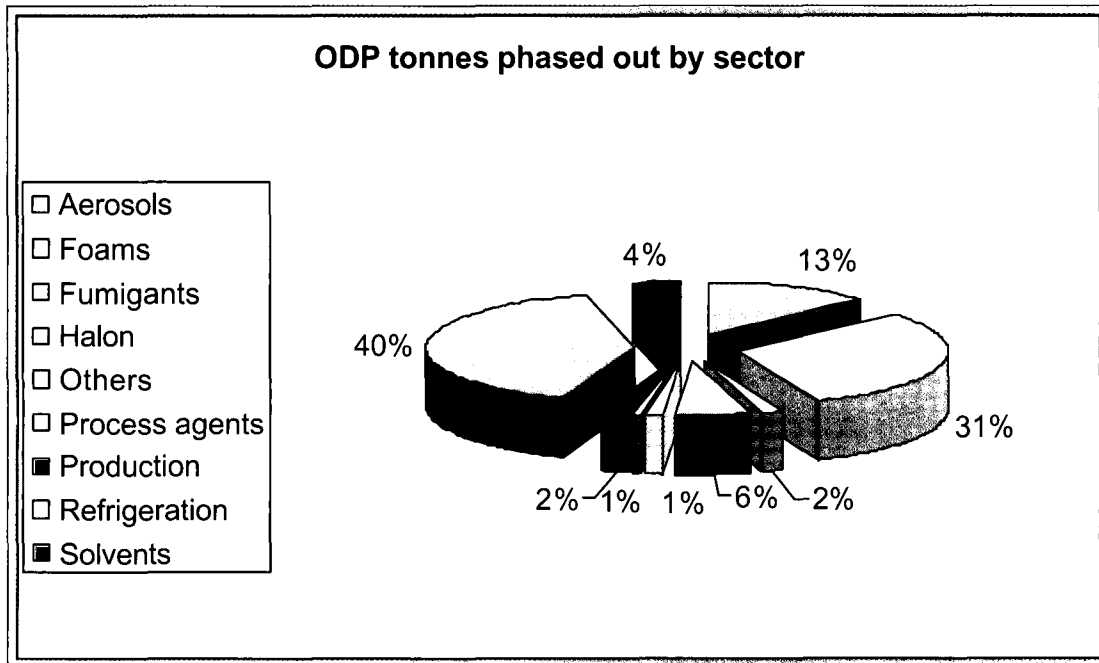


Fig. 4: ODP tons phased out by sector:
UNIDO projects by end 2002

Conceptual framework

Because the environment includes numerous and diverse stakeholders, each with different technical, administrative, economic, political and cultural interests and needs, sound planning and a structured approach are fundamental for the Montreal Protocol technology transfer process. For sustainability, interventions have to anticipate the actions that all essential stakeholders must take throughout the life of a project. They must also define the technical, administrative, institutional and financial building blocks required. UNIDO's approach analyses three basic areas:

- *The process to be used (process definition)*
- *The participants taking part (stakeholder identification and classification), and*
- *The goals and plans to achieve them (project planning).*

Box 1 – Technology transfer tasks monitored or managed by UNIDO

Decision-making

- Enterprise awareness of the potential for changing to non-ODS or ODS-conserving technologies in their operations
- Enterprise motivated to act

Preparatory assistance

- Identification of non-ODS technologies
- Evaluation of non-ODS technologies
- Selection of appropriate/preferred non-ODS technology

Project design and financing

- Project proposal prepared
- Project approval from relevant stakeholders
- Project approval from the Executive Committee of the Multilateral Fund
- Funds disbursed to UNIDO for the project

Project implementation

- Technology purchased or acquired
- Non-ODS product designed
- Non-ODS equipment/technology delivered and installed on the shop floor
- Non-ODS technology adapted to local conditions and put into use
- Relevant training carried out
- CFC related equipment destroyed in order to prevent back conversion.

Process definition is critical because each technology transfer project is in some ways unique. What works in one country or even in one company may not work in another. Simple duplication based on past successes may fail because stakeholders and their needs, motives and incentives may be different. The policy environment, institutional support and technical and managerial skill levels may differ. Thus, each stage in the process must be individually tailored to general considerations (such as design, financing and approval), and to specific ones (such as technology acquisition, adaptation, installation and long-term use). Box 1 indicates the tasks involved.

Stakeholder identification and classification is critical because stakeholder cooperation is essential during several stages of a project. Without it, they may even be in a position to undermine a project through overt action. Stakeholders include: developing country enterprises and governments, technology vendors (including suppliers of components and materials), donor countries, the Multilateral Fund together with MLF implementing agencies such as UNIDO. An essential element is to identify and understand the incentives that motivate each stakeholder in order to (a), design projects that will attract their support and (b) maintain their commitment. Recipient companies, one of the most important stakeholders, are responsible, for example, for acceptance and installation of new shop floor technology. Without their explicit cooperation and sustained commitment (including covering their counterpart cost obligations), successful technology transfer is not possible. Adding to the complexity, each enterprise has its own diverse set of players - engineers, managers and accountants - with their own priorities and goals.

Project planning prepares a set of goals and a plan that serve as a reference and quality assurance tool throughout the implementation process. It identifies the actions required of each stakeholder and, the critical steps in the technology transfer process. It also sets up channels of communication between them so that misunderstandings are minimized and loss of confidence in the project avoided. In addition, project planning outlines targets for the quantity and quality of products to be manufactured when the project is completed.

Strategy and tactics

The individual sectors addressed by UNIDO Montreal Protocol programmes are discussed in other booklets in the series along with specific case studies that assess their impact. Experience shows that successful programmes need to take into account a number of broad strategic and tactical considerations.

(a) Prerequisites and identification and assessment of critical stakeholder needs.

Without explicitly addressing these needs and concerns, success is unlikely. Features that increase the complexity of the task are:

- A multi-step process involving several players in different countries
- Absence of a single authority to direct concerted action by all parties
- Multiple priorities competing for the attention of stakeholders.

Project designers and implementers such as UNIDO must be able to understand what motivates the individual stakeholders. Since successful technology transfer is not simply the shipment of equipment, it is important to arouse and sustain genuine interest over the long term. Technology transfer includes adaptation to local conditions, modification of final products, training of indigenous technicians and long-term maintenance and the use of the delivered equipment. What may work in one country does not necessarily work in another. Mere replication will often fail, in fact, even in an identical industrial setting and with the same technology.

(b) Successful programmes depend on strong institutional competencies in recipient countries. Where a host government lacks an ozone protection unit with the requisite skills to act as a focal point for ODS phase-out within the country, then successful technology transfer is difficult to achieve. Such in-country administrative and management skills are sometimes more important than specific technological expertise.

(c) Market Realities. Key stakeholders are profit-driven enterprises influenced by market forces. Thus, in developing countries where prices of ODS are less than those of substitutes, stakeholders are slow to adopt and implement the new technologies. Conversely, companies in developing countries that export to markets in developed countries have adapted relatively quickly to non-ODS technologies - driven by the incentive to comply with customer specifications and import regulations in those countries. Financial subsidies from the Multilateral Fund might motivate a company to adopt a new technology. Experience shows, however, that it will only be maintained over time where long-term cost reductions can be realized. Unfortunately, many vendors of new technologies do not have a significant presence in developing countries - either due to risk aversion or because local markets are too small to justify such a presence. This in turn influences enterprises in developing countries that are wary of maintenance costs for new technologies over the long term.

(d) Technology transfer requires time. Successful technology transfer is a complex challenge. Major transformations have to be accomplished with limited resources in diverse environments, in which major economic, political, institutional and technical constraints have to be overcome. Additional complications can result from priorities being placed by governments on key social issues detached from the environment. Thus, time and patience are important factors in achieving success.

(e) Critical information needs to be properly disseminated. Many companies prefer to continue using technologies they know rather than use alternatives with which they are unfamiliar, even though those alternatives may cut costs. They also wish to be certain that alternatives will perform to acceptable quality levels and will not be replaced in the near future. It is imperative to provide such companies with clear and authoritative data on prices as well as on technical and financial details.

(f) Operational considerations. It is important that individual projects are designed and implemented with maximum flexibility. This enables them to respond effectively in dynamic environments in which there is also a great deal of scepticism about international projects. Thanks to its willingness to get involved with them on the ground, in their own geographic or industrial setting, and to communicate with them about their ideas and concerns, UNIDO is uniquely positioned to gain the confidence and trust of key stakeholders. The Organization's core competence in project management and its technical skills in the manufacturing environment give UNIDO the requisite tool kit of resources to foster technology transfer under the Montreal Protocol.

Sectoral focus

The diverse engineering and manufacturing technologies addressed by UNIDO in the implementation of its responsibilities within the Montreal Protocol fall into three basic groups: discrete manufacturing, continuous process manufacturing and agro-related industry. Discrete manufacturing refers to engineered products comprising unique parts that need to be machined or fabricated, sub-assembled and assembled. Continuous processing refers to highly automated and capital intensive manufacturing, for example in the chemical industries.

The refrigeration sector exemplifies the discrete manufacturing process group. It includes both the manufacture of domestic and industrial refrigerators, and fixed and mobile air condition systems. In most cases, substituting non-ODS alternatives for CFC-based ODS refrigerants and insulation used in manufacturing of refrigerators and air conditioners requires extensive redesigning or re-engineering of the product, including critical components such as compressors. Conversion requires rethinking the manufacturing process - not only the production machinery and assembly systems, but also tooling such as jigs and fixtures. Management systems (including quality assurance and safety) have to be reassessed. UNIDO has taken the lead in both the selection of non-ozone depleting alternatives, and in advising and managing the re-engineering and conversion process. UNIDO was the first implementing agency to move directly to hydrocarbons such as cyclopentane for manufacturing insulation foams, instead of proposing hydrochlorofluorocarbons (HCFC) - an intermediary technology from the perspective of the Montreal Protocol. Likewise UNIDO moved directly to hydrocarbons such as isobutane for refrigerant, instead of proposing hydrofluorocarbons (HFCs), which are greenhouse gases. UNIDO took a proactive role in compressor redesign, and helped maintain baseline quality and safety when advising on selection of alternative technologies.

The foam, solvents and process agent sectors are examples of continuous process manufacturing. Nevertheless, each exhibits diverse engineering and manufacturing technologies as well as applications. Ozone depleting solvents are used primarily to clean parts before machining, fabrication and assembly. UNIDO focuses only on substituting of ODS solvents with non-ODS alternatives - and not in their manufacture. Process agents are solvents that are used in chemical production processes in order to dissolve, suspend or extract materials in the process without chemical change in the materials or in the agents themselves. UNIDO's role includes both the phase-out of ozone depleting process agents and their substitution with non-ODS alternatives, as well as advising in their manufacture. UNIDO's phase-out approach to solvents encompasses in-process environmental protection and safety, without compromising profitability.

The foams addressed by UNIDO are engineered plastics that serve as components of a final product. Examples are: flexible polyurethane foams for bedding and upholstery, flexible polyurethane moulded and integral skin foams for automotive and office furniture industries applications, and rigid polyurethane insulation foam panels for the refrigeration and construction industry. UNIDO both helps with the phase-out of ODS foam blowing agents and with the manufacture of non-ODS alternatives. A particular trademark of UNIDO projects has been an umbrella approach that links together groups of projects that

address an entire industrial sub-sector in a country. UNIDO pioneered the promotion of liquid carbon dioxide (LCD) blowing technology and the use of an ODS phase-out approach that includes factory rationalization - covering costs, productivity, quality, safety and know-how transfer.

The fumigants programme serves to phase methyl bromide out of agriculture and helps apply its alternatives. Unfortunately, there is no single alternative fumigant that can readily substitute for methyl bromide in terms of efficacy, low cost, ease of use, availability and safety. Multiple alternative control measures are required, selection of which is made more difficult because of variations in target pests, soil types and climate. Thus, in order to select the most suitable alternative technology, in most countries demonstration projects need to be designed and implemented, taking into account climatic conditions, soil and crops. UNIDO has been the driving force behind the funding and implementation of demonstration activities, including convincing the Executive Committee of the Montreal Protocol that such an approach is the only way forward in terms of convincing farmers to switch to non-ODS technologies.

In summary, the UNIDO technology transfer programme within the Montreal Protocol is much more than an exercise in the phase-out of ozone depleting substances and their replacement by non-ODS alternative technologies. It is an activity that encompasses best practices in manufacturing, trade facilitation, training, know-how transfer, quality, safety and sustainable development.

Acknowledgements

This document was prepared by the United Nations Industrial Development Organization, Programme Development and Technical Cooperation Division, Multilateral Environmental Agreements Branch.

Produced with the support of Documents Control, United Nations Office Vienna

Cover design by Electronic Publishing Unit, United Nations Office Vienna

Printed by Printing Unit, International Atomic Energy Agency, Vienna, Austria.

