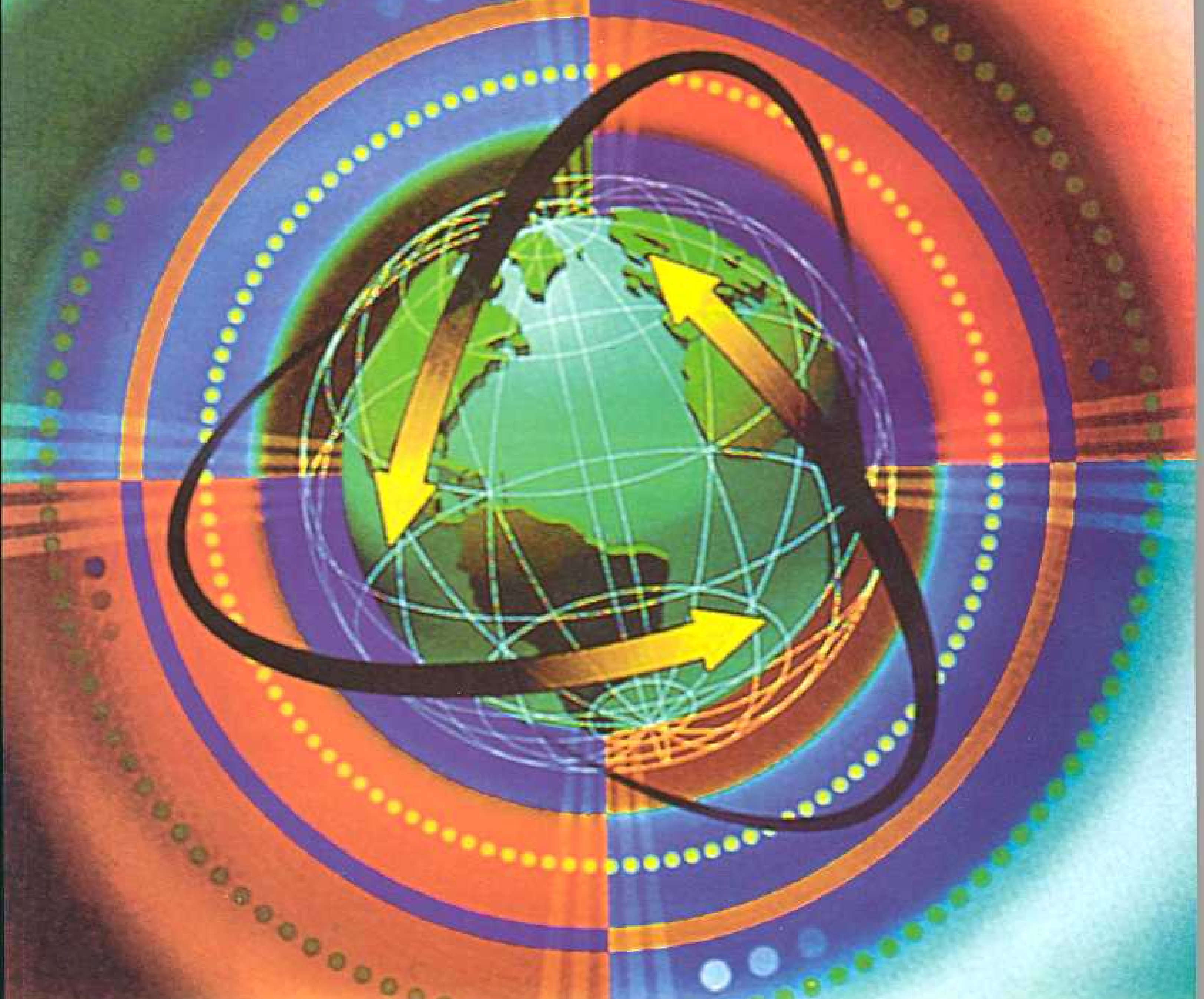
Louder Lessons in Technology Transfer

Lessons learned and case studies



Centre for Science and Technology of the Non-Aligned and Other Developing Countries

UNEP
United Nations Environment Programme
Division of Technology, Industry & Economics

APCTT
Asian and Pacific Centre for Transfer of Technology of the Eco & Soc Comm for the Asia & the Pacific

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Technology Transfer Workshop held in Bangkok, Thailand in March 1999 under the Montreal Protocol on Substances that Deplete the Ozone Layer

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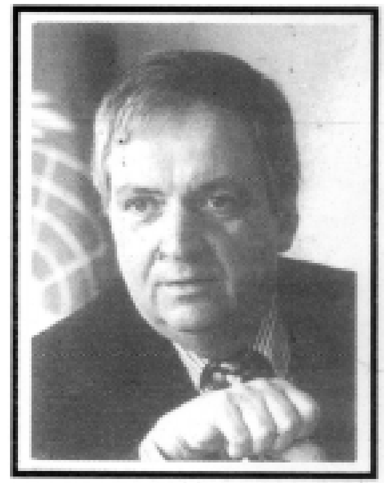
Preface



It has now been fourteen years since the signing of the *Montreal Protocol on Substances that Deplete the Ozone Layer.* During this, a number of successful results of international cooperation to phase out ozone-depleting substances (ODS) have become clearly visible.

For example, science has shown that the concentration of CFC-11, one of the controlled substances under the Protocol, is declining in the stratosphere. Industrialized countries have stopped the production of such ODS as CFCs, halons, carbon tetrachloride and methyl chloroform since 1994, except for some 10,000 tonnes per year for essential uses for which acceptable substitutes are not yet available. And as of July 1999, developing countries have frozen their production and consumption of CFCs, and subsequent control measures will be in place very soon.

Since its creation in 1991, the *Multilateral Fund* of the Montreal Protocol has allocated over US one billion dollars to fund investment and non-investment projects to phase out ozone-depleting substances. These projects have shown tremendous capacity for the successful transfer of ozone protection technologies, not only from developed to developing countries, but also between developing countries themselves. This success is highlighted by the fact that the private sector was very much a partner in the process, and still continues to be.

This document illustrates experiences gained from successful technology transfer under the Montreal Protocol by countries in the Asia-Pacific region. In having compiled and analysed a number of case studies, ten key lessons came to light – lessons that can protentially be used for guiding the transfer of environmental technologies under other international conventions, especially the international convention to mitigate climate change.

Actions to protect the ozone layer, including technology transfers, have grown by leaps and bounds. This would not, however, have been possible without close cooperation between governments and industry that have come together to ensure that environmental considerations come first before economic gain.

United Nations Environment Programme (UNEP) is very happy to be associated with this document, and would like to extend its heartfelt appreciation to the Asian and Pacific Centre for Transfer of Technology (APCTT) and the Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre) for a very successful collaboration.

Dr. Klaus Töpfer
Executive Director
UNEP

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INTRODUCTION

The purpose of this publication is to present the findings and main conclusions from the case studies presented in the technology transfer workshop that was held in Bangkok, Thailand, from March 1-3 1999.

The workshop brought together representatives of government and industry from countries in the Asian-Pacific region that have completed the conversion from ODS to non-ODS and had significant experiences as both suppliers and recipients of ozone-friendly technologies.

During that workshop, it was concluded that the OzonAction Programme of UNEP's Division of Technology, Economics and Industry (DTIE) would coordinate follow-up activities for the workshop, including the production of a proceedings focusing on successes in the region, to be disseminated to a wider audience.

As a result of those efforts, this publication begins with a background description of the Montreal Protocol, recent successes, and the increasing need to assist developing countries in phasing out ozone-depleting substances (ODS). The background section then presents successes of the Multilateral Fund under the Montreal Protocol, related successes in developing countries and background to the workshop itself. The section ends with the need to use lessons learned through technology transfer under the Montreal Protocol for guiding the transfer of environmental technologies under other international conventions, especially the international convention to stop climate change and the Kyoto Protocol.

The next section lists the ten lessons learned through technology transfer under the Montreal Protocol by both private and international organizations. Six case studies from the private sector and four from international development organizations are then described in detail.

Finally, an Annex at the end of the publication provides more specific information on the workshop logistics, and about UNEP's Division of Technology, Economics and Industry and its OzonAction Programme, Asian and Pacific Centre for Transfer of Technology and the Centre for Science & Technology of the Non-Aligned and other Developing countries.

BACKGROUND

Eleven years after the *Montreal Protocol on Substances that Deplete the Ozone Layer* entered into force in 1989, the successful results of international cooperation to phase out ozone-depleting substances (ODS) have become clearly visible.

For example, the concentration of one of the controlled substances, CFC-11, is already declining in the stratosphere. And since January 1994, industrialized countries have stopped the production of ODS such as CFCs, halons, carbon tetrachloride and methyl chloroform, except for some 10,000 tonnes per year for essential uses for which acceptable substitutes are not yet available.

The key issue now is that developing countries have become the world's major users of ODS. This is partially explained by the fact that, under the Montreal Protocol, they were given a grace period of approximately ten years after control dates for developed countries to phase out ODS. Attention is therefore now increasingly focused on cooperation between developed and developing countries to eliminate the production and consumption of ODS in developing countries.

The main example of this cooperation has been the *Multilateral Fund,* created in 1990 by the Parties to the Montreal Protocol to provide financial and technical assistance to *Article 5 Parties* (developing countries where production and consumption fall below a set threshold). Assistance is geared to ensuring compliance with the control measures set out under the Protocol and to phase out ODS.

In the global arena, the Multilateral Fund has become one of the most successful funds ever established for resolving an environmental problem, says Dr. Steve Andersen, co-chair of UNEP's Technology and Economic Assessment Panel (TEAP) and convenor of the Task Force studying hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

To date, over one billion US dollars have gone to developing countries for funding both investment and non-investment projects to phase out ODS, leading to a phase-out of more than 145,000 ODP (ozone depletion potential) tonnes. Over 110 countries completed their *Country Programmes,* which covers an estimated production of 70,000 ODP tonnes and consumption of 160,000 tonnes of ODS – representing 95 percent of ODS consumption and 100 percent of ODS production in Article 5 countries. And all these countries are being assisted to enhance their capacity to protect the ozone layer through institutional strengthening projects. The Fund has often even led led to early ODS phase-out in many developing countries.

Projects approved, completed and currently being implemented also promote the transfer of environmentally sound technologies to developing countries. And many of these are actually "leading-edge" technologies in the global market, says Mr. Tony Hetherington of the Multilateral Fund. Examples include hydrocarbon technologies for both foam and refrigeration, carbon dioxide for foam blowing and dry ice technology for tobacco fluffing.

Elements that have ensured the success of the Multilateral Fund, notes Dr. Anderson, include: strong global and local public concern; technical innovation and commercialisation; enterprise-targeted, locally adapted technical choices; government leadership; corporate leadership and pledge campaigns; information, training and awareness-raising programs; and suitable financial and market forces.

The Asia-Pacific region in particular has taken a significant lead in phase-out initiatives under the Montreal Protocol. It has benefited most among all the regions in terms of the number of approved projects under the Multilateral Fund. And some of these investment projects have already been completed leading to a significant phase-out of ODS.

In order to share the successes of the Asia-Pacific region, a technology transfer workshop highlighting the lessons learned in Asia-Pacific countries was organized jointly by the United Nations Asian and Pacific Centre for Transfer of Technology (UN-APCTT), the Centre for Science and Technology of the Non-Aligned and other Developing Countries (NAM S&T Centre) and the Energy and OzonAction Programme of UNEP's Division of Technology, Industry and Economics (DTIE).

The workshop got together enterprises that supplied the technologies and those who received and deployed it. The National Ozone Units from these countries were also invited. The implementing agencies (UNDP, UNIDO and UNEP) that were involved in assisting the project activities took active part in the discussion and sharing of experiences.

The main objectives of the workshop included the sharing of experiences on how projects with technology transfers were implemented under the Multilateral Fund. Challenges faced by Article 5 countries in project identification, approval, implementation and evaluation were reviewed to understand the practical barriers faced by enterprises and governments. And successfully transferred technologies were identified, highlighting the potential for replication by other countries in the region and related barriers.

It was observed that the experiences of the countries and enterprises presented during the workshop could provide the elements for completing ODS phase-out in other developing countries and regions of the world. Just as importantly, they may also inform the implementation of other international conventions, especially the convention on climate change and the Kyoto Protocol.

Dr. Ogunlade Davidson, co-chair of Working Group III of the Inter-Governmental Panel on Climate Change (IPCC), stressed the importance of the workshop in relation to discussing cross-cutting issues between the Montreal and Kyoto Protocols. He looked forward to getting inputs from the presentations that might be useful for him during future IPCC discussions. He emphasized the need to learn from the technology transfer activities under the Montreal Protocol's Multilateral Fund. And he also noted that the IPCC was preparing a report on technology transfer which will assess options to reduce greenhouse gas (GHG) emissions through various mechanisms including technical cooperation. This report, entitled Methodological and *Technological Issues in Technology Transfer,* was later published in 2000.

Finally, on behalf of UNEP TIE, Mr Rajendra Shende, Chief of the Energy and OzonAction Unit, stressed the uniqueness of the workshop. He stated that workshop has brought together all the actors involved in the technology transfer i.e. supplier, recipient, government and implementing agencies that were involved in the projects. Given the participation of representatives from both the IPCC and the Technology and Economic Assessment Panel (TEAP), he highlighted the opportunity to openly discuss the issues related to the technology transfer under both the Kyoto Protocol and the Montreal Protocol.

The Ten Lessons of Technology Transfer

The following ten lessons represent the main conclusions of the technology transfer workshop held in Bangkok, Thailand in March 1999.

ONE
Technology transfer is a collaborative effort.

TWO
The process cannot take place in isolation.

THREE
Be consistent with national programmes.

FOUR
Project planning should be comprehensive.

FIVE
Market forces play a crucial role.

SIX
Rely on indigenous technologies where possible.

SEVEN
No training, no transfer.

EIGHT
Disseminate information and keep the public aware.

NINE
Present clear political guidelines.

TEN
Consider the Montreal Protocol's interface with the Kyoto Protocol.

EXPLANATIONS OF THE TEN LESSONS

1) *Technology transfer is a collaboraive efforts.*

The process of technology transfer under the Montreal Protocol involves many more stakeholders than just the supplier and recipient. Other stakeholders include implementing agencies and their operational arms, international and national consultants, *National Ozone Units,* equipment, chemical and industrial associations. Active cooperation, partnership and synergy between all stakeholders are required. Consultations with the market needs and clients on their needs is crucial.

Particularly important is that implementing agencies (in this case UNDP, UNIDO, UNEP and the World Bank) should play a catalytic role in making this diverse web of partnerships work, following the guidelines and policies of the Executive Committee of the Multilateral Fund.

Thailand: The case study of the compressor manufacture clearly indicates the benefit of collaboration with the customers and consultation with the Government of the recipient country.

India: MAC sector project indicates that collaboration with suppliers of nitrogen gas would have been beneficial.

2) *The process cannot take place in isolation.*

As noted above, the whole process of conversion from ODS to non-ODS technologies involves many stakeholders working together. Enterprises cannot be expected to successfully implement technology transfer by themselves.
In effect, the process requires a supportive environment with actions taken by government and industry, through a proper balance of incentives and disincentives.

Examples of these actions, or *facilitating measures,* on the part of the government include the establishment of a specific policy and legislative framework (i.e. with taxes imposed on ODS-using equipment), eco-labelling programmes and public awareness-raising programmes. For example, Malaysia, the Philippines and Korea have enacted legislation related to banning the import and sale of new ODS-containing equipment.

Examples of facilitating measures by the private sector side include the setting of standards by industrial associations and training programs for incorporating new non-ODS-using technologies into in-house production processes.

Financial incentives are a particularly important facilitating measure, especially the financial grants under the Multilateral Fund that provide funding for the transfer of technology under the Montreal Protocol.

Malaysia: The government discourages investments relating to the production and use of ODS, especially CFCs and halons. It also promotes voluntary compliance in the reduction and phase-out of ODS before the Montreal Protocol's target dates.

For example, the country's Environmental Quality Order 1993 (Prohibition on the Use of CFCs as Propellants and Blowing Agents), which entered into force in June 1994, specifically prohibits the use of ODS in any aerosol-related manufacturing process or trade.

Environmental Quality (Refrigeration Management) Regulations have been introduced to control any new installations of chillers (large refrigerating equipment) and for the venting of refrigerants. A certification system will also be established, requiring refrigeration technicians to be trained in refrigerant reclamation and recycling.

Other governmental policy measures implemented in Malaysia to facilitate technology transfer, discourage the import of CFC products and to avoid the dumping of poor technologies include:

- conrolled import of CFCs through the use of an Application Permit System;
- increased import duties on CFCs from two to ten percent;
- increased import duty on refrigerators containing CFCs;
- abolished import duty on R-134a and minimum import duty imposed on HCFCs;
- the establishment of a non-CFC labelling scheme; and
- the introduction of a certification system for ozone-friendly products.

The government also promotes joint public awareness campaigns for industries and suppliers and has published a series of ODS publications for use by the general public and industries.

Bangladesh: Facilitating measures include awareness-raising seminars for the general public, technical trainings on the use of new technologies for industry, a study to evolve a policy and institutional framework for implementing and monitoring the Country Programme and awareness-raising programmes for importers of refrigerators and air-conditioners and importers and users of ODS. The Department of Environment of Bangladesh in particular has implemented information programmes for policy- and decision-makers, technicians and personnel engaged in the servicing of ODS-based equipment, and for the general public about the harmful consequences of ozone layer depletion and ways to avoid them.

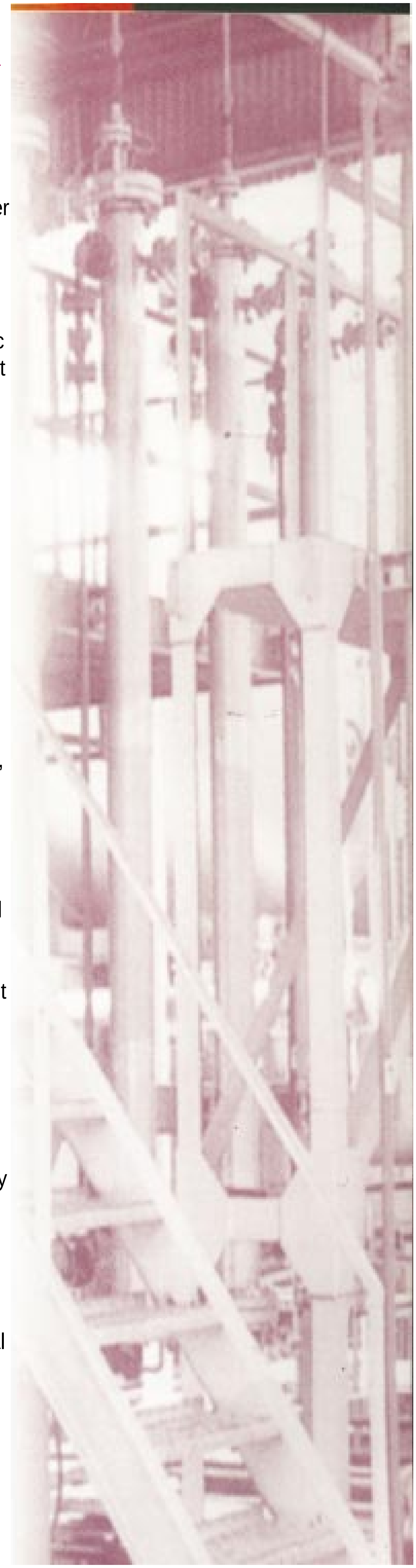
Indonesia: The country has conducted campaigns to raise awareness among the general public and industrial training programmes. It has also formulated and established regulations to control the imports of ODS-containing equipment.

3) Be consistent with national programmes.

The **Country Programme** is the basic document outlining a country's approach, priorities, objectives and strategies for implementing the Montreal Protocol. Any transfer of technology under a recipient's Country Programme should be consisting with its national programs, including strategies related to industrial development.

For example, a primary concern of many recipient countries, as manifested in their national industrial strategies, is that they should avoid old and outdated technologies. Otherwise, they risk having inefficient industrial production and environmental problems. Suppliers should therefore be aware of this concern and not force recipients to accept undesirable technologies.

Vietnam: Consistent with its Country Programme and industrial strategy, Vietnam emphasizes that a country should have a wide range of technology options from which to choose the best available. These should then be adapted to meet local capacities and conditions. Also in accordance with its national priorities, Vietnam has laid down minimum standards requiring that newly imported technologies:



- do not use ODS;
- correspond with and enhance national technological and scientific capabilities;
- assure economic growth; and
- meet national labour safety standards.

India: Consistent with its national industrial development strategy, India's Country Programme emphasizes a phase-out of ODS without undue burden to consumers and industry. More specifically, the main objectives of its programme which have a bearing on technology transfer have been geared to:

- minimizing economic dislocation as a result of conversion to non-ODS technology;
- maximizing indigenous production;
- giving preference to one-time replacement;
- emphasizing decentralized management; and
- minimizing obsolescence.

4) Project planning should be comprehensive.

Based on the experiences of technology suppliers and recipients, it can be concluded that the supply and installation of equipment alone is insufficient for the successful transfer of technology. The process should initially be guided by a comprehensive project planning process, particularly geared to assessing the *local* conditions, requirements and capabilities of the receiving enterprises.

Suppliers must first have a through understanding of the local environment to help them design technologies that best suit local needs. It is then crucial that all possible options are presented to recipients from the start through a project feasibility. If not, unforeseen eventualities may arrive during project implementation, which could drive up costs – a significant problem, especially as most funding under the Multiteral Fund, once granted, is fixed, requiring recipients to pay out unforeseen additional expenses themselves.

India: Local conditions were not considered early enough in the *Pranav Vikas Project.* The project originally planned for the purchase of nitrogen from an external source, required for creating an inert atmosphere in a furnace. However, once actual operations started, it was found that the quality of locally available nitrogen was not consistently satisfactory. As a result, the recipient enterprise had to install its own in-house nitrogen plant – an eventuality that should have been considered at the time of project formulation.

India: The Aerosol Demonstration Project is a good example of how local conditions can influence innovations in technology. In this project, an early analysis of local conditions led to a project formulation that incorporated the adaptation of new technologies to suit local requirements – in this case, manual filling machines were designed to suit the requirements of the fillers of small aerosol cans.

Another effective ingredient for project planning is the use of **pilot** projects and studies. Experiences gained from implementing small pilot projects are effective tools for formulating new guidelines and policies that can assist in comprehensively planning larger follow-up projects.

5) Market forces play a crucial role.

Under the Montreal Protocol,

market forces play a crucial role in affecting or facilitating the technology transfer process. They are particularly important in influencing an enterprise's decision-making process regarding alternatives and substitutes to ODS-using product. These for example include the:

- relative availability and costs of alternatives, replacement chemicals and basic components of non-CFC technologies for producers;
- profits lost or gained due to conversion;
- price and quality of end-products to consumers;
- local customer preparedness, awareness and demand for ODS-free products;
- impacts from conversion on export/import markets;
- origins of technology providers;
- intellectual property protection standards in recipient countries;
- liability concerns related to hazardous technologies;
- safety considerations (especially with aerosols and hydrocarbon technologies); and
- reliability and skills of the local work force.

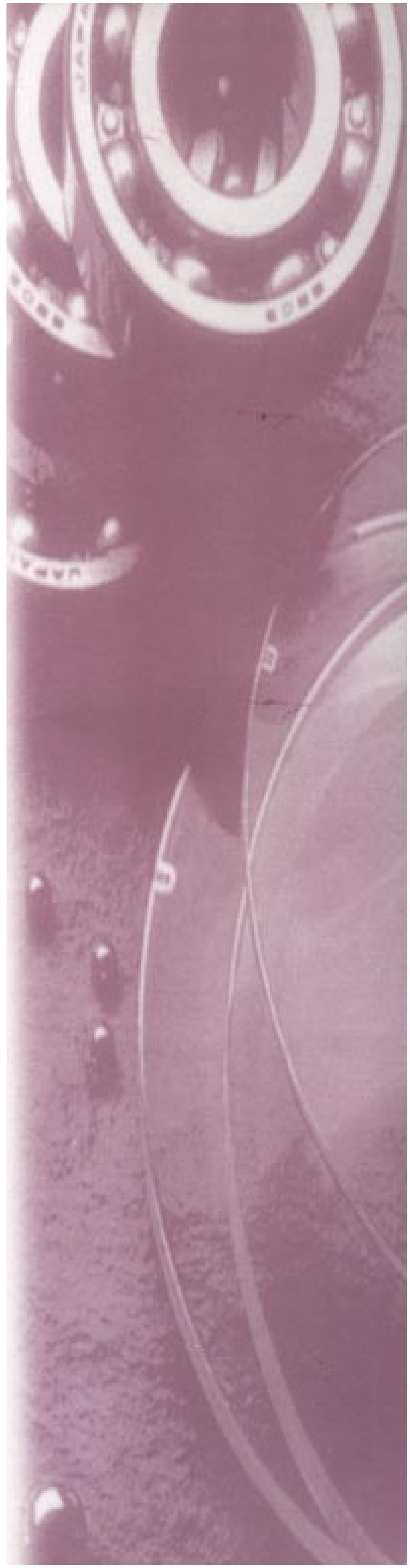
A recipient country's current *economic* situation influences the speed of technology transfer. For example, economic turmoil in the Southeast Asian countries, as occurred in Malaysia and Thailand in the 1990s, resulted in many industries being unable to meet the capital investments required for project implementation involving technology transfers.

The level of *competition* between enterprises is a key factor. This is especially true regarding the degree to which enterprises are converting to new products. Many enterprises will only choose new technology options if their products gain a competitive edge in the market. However, under the Montreal Protocol, enterprises in developing countries are allowed to continue to use CFCs as a result of the 10-year grace period afforded to them – they have until 2010 to fully phase out CFCs. As a result, those enterprises which opt for conversion could face a disadvantage if competitors save costs through the continued use of old technologies. At the same time, competing enterprises demand a level playing field wih no undue advantages in the market (i.e. subsidies for privileged enterprises from the Multilateral Fund).

The *availability* of alternatives and substitutes to ODS also affects the technology transfer process. For example, the products of *Promosol,* a company that promotes the use of CFC-free solvents, have been widely accepted in some Southeast Asian countries. Promosol's *no-clean technologies* are equipment that do not require cleaning nor cleaning solvents. In contrast, while hydrocarbon aerosol propellants (HAPs) are considered to be ideal alternatives to CFC propellants, the Southeast Asian region does not have a supplier of hydrocarbons. As a result, the non-availability of HAPs, particularly in India and Sri Lanks, has slowed down the process of conversion.

Malaysia: The country has reduced import duties on substitutes such as R134a, making them more readily available in local markets and facilitating a quick changeover to new technologies.

Another significant problem is the potential for enterprises that have



already converted from CFCs to switch back, or *backslide,* to CFC use. This may occur, for example, because a new technology may not be compatible with local conditions, it may be relatively more expensive or less available, or because it fails to perform as well as a former CFC-using technology. This is especially problematic when companies that have received funding to switch to alternative non-CFC technologies then switch back, with funders unaware of the backsliding.

6) Rely on indigenous technologies where possible.

The objective of quickly switching to non-ODS technologies has often led developing countries to transfer to proven and tested foreign technologies. However, small countries in particular fear excessive reliance on imported substitutes, mainly because the process has often discouraged the development of indigenous technologies.

In many cases, indigenous technologies are actually cheaper to produce, as they are often better suited to and designed in accordance with local conditions. Furthermore, using indigenous resources reduces overall transfer costs and the amount of funding required from the Multilateral Fund. Nonetheless, most developing countries continue to develop some indigenous technologies, and about six percent of ODS are now replaced by indigenous methods.

Bangladesh: An indigenous method for CFC recovery and recycling was encouraged and developed by refrigeration and air conditioner service technicians working in small local repair shops. As a result, the direct venting of CFC gases to the atmosphere has been greatly reduced.

Korea: Korea has created a supporting fund for research projects for the production of CFC alternatives. As a result, the basic design of local commercial plant for producing alternatives including R134a, HFC 125, HFC-152a, HFC-32, HCFC 22 and HCFC 141b/142b was developed.

Malaysia, India: These countries have been encouraging existing domestic industries to develop and use ODS substitutes, especially HFC-134a.

A major barrier in developing indigenous products is the *dumping* by Article 2 countries of CFC-using equipment and products, which they can no longer use given the restrictions of the Montreal Protocol, into Article 5 countries. For example, a significant volume of trade between Article 2 and Article 5 countries involves the export of new and second-hand appliances, many of which rely on ODS, from the former to the latter. As a result, indigenous product developers find it difficult to compete with retailers of cheaper CFC-using products.

In response, Article 2 countries should ensure that new or second-hand appliances (or other products, equipment, components and technologies) meant for export to and use in Article 5 countries do not involve CFCs or other ODS. They should also adopt other legal and administrative measures, especially the labelling of products, equipment, components and technologies for export to Article 5 countries.

7) No training, no transfer.

An integral part of any technology transfer process, training will significantly reduce time and money spent between commissioning and production. Employees and technicians of recipient enterprises must be trained extensively in using new technologies that have been designed in a foreign country by foreign technicians. Key areas include equipment installation, operation, maintenance and safety procedures.

Training is usually conducted by suppliers, and training costs should form an integral part of any technology transfer project or funding agreement.

Although not directly related to investment projects, training through capacity-building is also crucial for the process, such as training service technicians in ODS recovery methods.

Bangladesh: The Department of Environment has trained technicians in the refrigeration and air conditioning sectors.

8) Disseminate information and keep the public aware.

Consumer preparedness to accept non-ODS products may be the greatest facilitator in the entire process. In developing countries, increasing consumer awareness is leading to an increasing demand for non-ODS products and, consequently, faster technology transfers to make these products more available in the markets. Information disseminated specifically to potential recipient enterprises also facilitates technology transfer.

Bangladesh: Citizens have become significantly aware of the consequences of ozone layer depletion, reflected in increased local purchases of air-conditioners, refrigerators and insecticide aerosols with ODS-free devices. A recent survey in Bangladesh proves that some 20 percent of imported refrigerators are now CFC-free.

Malaysia: With assistance from industries and suppliers, a series of awareness-raising activities such as seminars, interviews in electronic media, feature articles in newspapers, exhibitions on technologies and ODS-free products and award presentations were carried out to encourage industries to phase-out CFCs quickly and to increase public awareness about ozone depletion.

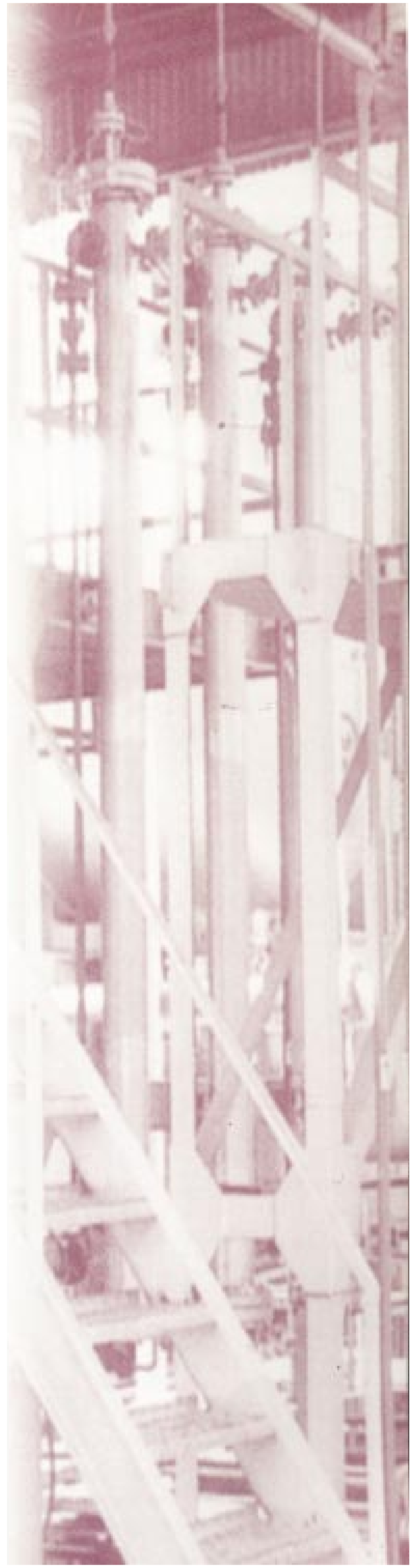
India: A demonstration project at India's Defence Institute of Fire Research helped in disseminating knowledge regarding the proper use of alternatives in the halon (an ODS) sectors.

9) Present clear political guidelines.

The Montreal Protocol itself, through Articles 10 and 10a, explicitly provides for technology transfer, thereby easing the way for the use of alternatives in developing countries. Under these same articles, financial assistance is provided through mechanisms that include the Multilateral Fund to enable countries to comply with their commitments under the Protocol. Such financial assistance is limited to the incremental costs that an enterprise in a country shall incur in moving to the use of non-CFC technology.

The Protocol also ensures that the best available and environmentally safe substitutes are expeditiously transferred to Article 5 countries under fair and the most favourable conditions. These provisions make certain that the approval of projects to be funded under the Multilateral Fund strictly follows the guidelines and procedures agreed to by the Executive Committee.

Phillipines: Technology transfer in the foam sector demonstrated that the success of the project would



have further enhanced, had the enterprises known the details of the incremental cost and funds that it needs to co-invest in the project.

10) Consider the Montreal Protocol's interface with the Kyoto Protocol.

A number of chemicals which have already been introduced and transferred as alternatives to ODS/CFCs have now also been identified as included in the basket of greenhouse gases controlled under the Kyoto Protocol on climate change, in view of their high global warming potential (GWP). These include, for example, HFCs and PFCs.

Implementation of the Kyoto Protocol could this result in control measures or bans imposed on these alternative substances. And having already gone through the technology transfer process, developing countries may again be forced to go in for yet another stage of technology transfer, obviously having significant economic impacts on industries and even national economies. Smaller countries are particularly at risk, given the limited funding they receive from the Multilateral Fund.

This is especially relevant for equipment using HFC-134a, now the alternative of choice in the refrigerating sector but also one of the Kyoto gases. If HFC-134a were to be phased out under the Kyoto Protocol, ODS phase-out could be delayed and affected countries will have to shift again to another technology alternative.

In any case, given that regulations under the Kyoto Protocol will involve further technological changes to be adopted by developed and developing nations, it will be worthwhile to draw lessons from the experiences of technology transfer under the Montreal Protocol to avoid pitfalls that were experienced in the earlier stages of its implementation.

And to address the concerns of both the Montreal Protocol and Kyoto Protocol related to technology transfer at the same time, supplemental funding from the Multilateral Fund, the Global Environment Facility (GEF) and other international funding mechanisms should be arranged.

Korea: To meet expected international regulations on greenhouse gases, Korea began the second stage of a research project in 1997 to assess next generation alternatives that are ODS-free with low GWPs.

Case Studies from the Private Sector

The following six case studies present a selected set of experiences of private Sector companies in Asian-Pacific developing countries in transferring non-ODS technologies under the Montreal Protocol.

Project 1	:	**Conversion of Compressor Manufacture from CFC-12 To HFC-134a Design**
Company	:	Kulthorn Kirby Public Company Limited
Location	:	Bangkok, Thailand

Keywords
Refrigeration, air-conditioning, ODS, CFC-12, HFC-134a, hermatic refrigerant compressors, connecting rod, capillary tube.

Summary
Thailand achieved successful ODS phase-out in its domestic refrigeration sector at the end of 1996. Until then, most Thai manufactured refrigeration and air conditioning equipment had utilized CFC-12 and HFC-22 as working fluids. Thailand was aided in its efforts by four Japanese companies, the Japan Electrical Manufacturers Association (JEMA) and a local compressor manufacturer, Kulthorn Kirby Public Company Limited (KK). Thailand's signing of the Montreal Protocol in 1989 had prompted its local refrigeration and air conditioning industries to establish conversion programmes to eliminate the use of ODS. In response, KK, with financial assistance from the Multilateral Fund via the World Bank, formally commenced the conversion project from manufacturing CFC-12 to HFC-134a in 1994, covering the implementation of both design testing and mass production. The project, aimed at indirectly eliminating approximately 115 tonnes of annual domestic consumption of CFC-12 in refrigeration systems, was successfully completed in December 1996, and full production of the new products for the domestic market began on January 1 1997. Since 1997, KK has been producing more than one million R-134a compressors serving both domestic and overseas markets annually.

Background
On March 24 1980, KK was initially established in Bangkok, Thailand with 70 percent Thai ownership. It commenced production of CFC-12 hermetic refrigerant compressors under the technology license of Tecumseh Products Company (TPC), Michigan, USA, on January 13 1982. It became a public company listed in the Thai Stock Exchange on February 22 1991. In March 1992, Japan and USA had a technical seminar in Thailand where the Japanese government, MITI and refrigerator manufacturers announced their intention to phase out ODS from domestic refrigerators in Thailand by the end of 1996. This date was only one year later than that for developed countries, including Japan, under the Montreal Protocol.

Approach
The KK conversion project from the manufacture of CFC-12 to HFC-134a hermetic refrigerant compressors consisted of two phases of implementation. Phase 1 involved the testing and evaluation of nine compressor models in the AE compressor family, originally developed by TPC, to modify the design to suit local usage conditions. Two important objectives considered in the adaptation of the technology included the development of a wide voltage tolerance compressor motor and retention of the compressor efficiencies as obtained through the use of CFC-12.

KK received assistance from its partner, Kirby Refrigeration (Australia), for improving compressor-pumping performance. KK engineers were also trained at the TPC compressor plant (USA), and qualified consultants from Kirby Refrigeration were at KK's disposal throughout the implementation stages. Life and field tests within KK were completed in early 1995.

At the same time, KK had promised to supply compressors to Japanese companies manufacturing refrigerators in Thailand. Problems were encountered with the new compressors during life tests conducted by the Japanese companies including connecting rod wear and capillary tube contamination. In response, JEMA sent a technical expert team to KK while more than 500 samples were long-run tested in four Japanese companies. High-quality samples were finally obtained after a successful 8,000 hour-long test. As a result, it became possible to manufacture new ODS-free refrigerators successfully before the end of 1996, procuring good quality compressors from KK.

Phase 2 was entirely associated with KK's HFC-134a mass production plan. The project activities included the procurement of new manufacturing equipment, modifications to some of the existing manufacturing facilities, acquisition of foreign experts for technical advice and staff training.

Impact

The targeted elimination of 115 tonnes of CFC-12 was achieved. This was substantiated by the fact that no CFC-12 compressors were purchased by OEM domestic refrigerator manufacturers in the years following project completion. There was also an increase in research and development activities within the company, awareness of environmental issues, participation of the company with outside organizations with regardto technology transfer, and awareness of the environmental implications of future products. Furthermore, the transfer and changes in design led to improved awareness and abilities throughout the organization, especially related to quality manufacturing.

At the trilateral follow-up meeting, manufacturers requested the Thai government to take measuresto prevent the import of low-priced refrigerators using CFCs. As a result,

Compressor manufacturing assembly line

the Thai government and Department of Industrial Works promptly took action and banned the import of CFCs and CFC-containing refrigerators.

Lessons learned

Any potential customer participation in the conversion project should be initiated at the start of the programme and such involvement should be maintained throughout the entire programme.

Advice must be sought from the recipient country's authorities for insight into what the country's long-term conversion plan will cover, to be accommodated by any new technologies.

Initial confirmation on the availability of reliable sources from suppliers for both raw materials and equipment suitable for the new technology is necessary.

In developing countries, the strengthening of private sector research and development ability is more sustainable than relying solely on technology transfers from wealthy developed countries.

Some financial assistance from the Multilateral Fund should be made available to local, small producers of refrigeration systems and repair shops, which lack the technology and funds to convert to non-ozone depleting technologies on their own.

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Project 2	:	**Experience in Technology Transfer in Refrigeration and MACs: Aluminium Brazed Parallel Flow Condenser Technology**
Company	:	Pranav Vikas Limited
Location	:	India

Keywords

Heat exchangers, condenser, R-12, HFC-134a, PFC, SSC

Summary

The Indian company, Pranav Vikas Limited, manufactures heat exchangers for the mobile air conditioning (MAC) industry. To eliminate the use of ODS in condensers, a policy decision was taken to switch over to the production of equipment suitable for using HFC-134a. The German company, ARUP GmbH, was chosen as the technology partner to help in the implementation of the technology transfer. As a result, the production of condensers using HFC-134a was successful and Pranav Vikas now supplies their redesigned products to major car manufacturers.

Background

Pranav Vikas originally manufactured condensers of the skived aluminium serpentine design, which were suitable for use with R-12 refrigerant. A decision was then made to switch over to HFC-134a to eliminate the use of ODS. Since this switchover was to be done without increasing the size of the condenser, a change in design and technology was involved, as HFC-134a systems are approximately 12 percent less efficient than R-12-based systems and thus require an increase in condenser capacity. This capacity increase had to be achieved without a corresponding increase in size, as space in automobiles for installation of air conditioners is defined and limited. The existing condensers of skived aluminium serpentine design were unable to meet these higher requirements and hence a switchover to aluminium multi-flow condensers was necessary. This new technology was not available within the company and it was necessary to seek technical assistance.

Approach

Contracts were established with leading manufacturers of HFC-134a MACs, but it was found that the new technology was either not easily available or was guarded by patent restrictions. Manufacturers of production equipment and raw material suppliers were then consulted with a view to identifying a suitable agency to render the technology transfer. After a considerable search, ARUP GmbH, a leading German manufacturer and supplier of headers used in MAC industries, was selected. ARUP possessed the required technology and was considered competent for the design and development of aluminium brazed parallel flow condensers.

An 18mm thick parallel flow condenser (PFC) is equivalent to a 44mm thick serpentine skived condenser (SSC) with the same capacity. It weighs, however, approximately 50 percent less. It minimizes air pressure drop and radiator heat load due to a super-thin profile. It also saves 10 percent refrigerant usage of the circuit as compared to an SSC.

The major equipment required for the production of the new design included a tube decoiler/straightened, fin cutting machine, core builder, tooling for various PFC and a CAB furnace.

The technology transfer also involved the transfer of technical information, and technical assistance and know-how for the design, manufacture and assembly of aluminium brazed parallel flow condensers.

ARUP assisted with the various stages of project design, implementation and induction of the new technology. They also assisted with the installation of the equipment and the start-up of production. Their qualified experts were present during critical stages of project development and technology transfer. They also maintained liaison with the suppliers of major equipment to ensure suitability.

Lesson Learned

Training for recipient employees was hosted on-site by the technical collaborators. The limitation of this training, however, was that the employees could not be trained in a factory actually producing condensers of the new design, using similar equipment and technology, because the technical collaborators did not themselves produce complete condensers.
Another problem was that the project provided for the purchase of nitrogen from an external source, required for creating an inert atmosphere in a furnace. However, once actual operations started, it was found that the quality of locally available nitrogen was not consistently satisfactory. Consequently, an in-house nitrogen plant had to be installed.

Mr. Shende (UNEP) watching the non-ODS Condenser being displayed by M/s Kanwar and Kuldip Singh at the workshop.

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Project 3	:	**Experience in Technology Transfer in The Foam Sector**
Company	:	RGC Foam Group
Location	:	Philippines

Keywords
PU foam, Freon-11, waterblown technology, methylene chloride

Summary
When the Multilateral Fund was made availablem RGC had already phased out its CFCs in flexible slabstock manufacture and had started to shift to waterblown technology in moulded foam. UNDP helped RGC in phasing out the residual CFCs by providing technical assistance and funding.

Background
The RGC Foam Group (Philippines) has been a manufacturer of polyurethane (PU) foam since 1968, producing flexible slabstock foam, moulded flexible foam, integral skin foam and rigid foam. CFCs in the form of Freon 11 had been the traditional auxiliary blowing agent for PU foam manufacturers.

RGC had already phased out CFCs in the flexible slabstock manufacture and had started to shift to waterblown technology in moulded foam. For the rest of the applications, however, the phasing out of CFCs was regarded as difficult and not feasible. At this point, UNDP initiated talks with RGC Foam Group to jointly undertake a project to phase out the residual CFCs.

Approach
UNDP provided technical assistance to address the RGC's difficulty in phasing out CFCs in its more difficult operations (i.e. those involving substantial changes in the cost structure and product quality which may not find 100 percent market acceptability as well as those involving a radical change in the manufacturing process). UNDP dispatched technical experts to guide RGC with the new technology. These experts assessed RGC's factories, disseminated information on all available technologies, assisted in choosing the right technology, supervised the implementation of the project, and fine-tuned and applied corrective measures to the newly adopted technologies. UNDP also provided funding under the Multilateral Fund.

RGC had accomplished the phase-out in flexible slabstock foam on its own. UNDP assisted RGC in making the substitution to methylene chloride sustainable in the long run. It raised the awareness of RGC with regard to legislation and trends surrounding the use of methylene chloride in aspects of health and safety, as a result of which proper ventilation and safe handling systems were installed. It also introduced liquid CO2 as the direction of the future.

In the case of flexible moulded foam, RGC had begun the transfer to all waterblown systems. UNDP completed the transfer by subsidizing the cost of replacing low-pressure machines with high-pressure machines, which can handle high-viscosity waterblown systems.

In the case of supersoft foams, UNDP introduced to RGC the technology of a softening additive. UNDP helped RGC choosing the correct raw materials for the interim conversion to HCFC-141b in the integral skin foam and rigid foam sectors. Ultimately, a conversion to all waterblown systems is foreseen.

UNDP experts also fine-tuned the formulations of RGC products to remove any problems of market acceptability, and subsidized the cost of samples and trials.

Impact
Everyone within the companyt was

educated about environmental responsibility. Financial assistance from the Multilateral Fund led to reduced apprehension within the company to adopting the change. The undertaking provided RGC with an elaborate network of contacts, such as experts, raw material suppliers and machine suppliers, which will ensure the continuous flow of information and help sustain the project beyond its economic life. And the phase-out of CFC led to the adoption of state of the art technology with additional benefits.

Lessons Learned

Since the technology is considered to be *too new,* there are concerns regarding: the company becoming a *guinea pig;* how a set-up in a developing country can sustain a developed country's technology in terms of funds and market; the expense of the new technology; the acceptance of subtle changes in product quality by consumers; confidentiality of proprietary information, as the same UNDP experts visit competitors as well; and companies lacking the funds to shoulder their share of costs.

Future plans

Methylene chloride is quickly becoming a subject of legislative and administrative restrictions due to health concerns. As a result, the replacement of methylene chloride by liquid CO2 in the medium-term is being considered.

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Project 4	:	**Conversion of Hydrocarbons in the Manufacture of Aerosol Products**
Company	:	Packserve
Location	:	Thailand

Keywords

CFC aerosol propellants, hydrocarbon aerosol propellants, flammability, safety.

Summary

The project, a collaboration between Packserve of Thailand and Terco of USA, involves the conversion of CFC aerosol propellants to hydrocarbon propellants at Packserve. During the project, it was necessary to consider the entire production line and not just the propellant filling operation. Safety was an important aspect due to the flammable nature of some of the products and the very low flash point and high flammability of the hydrocarbon propellants.

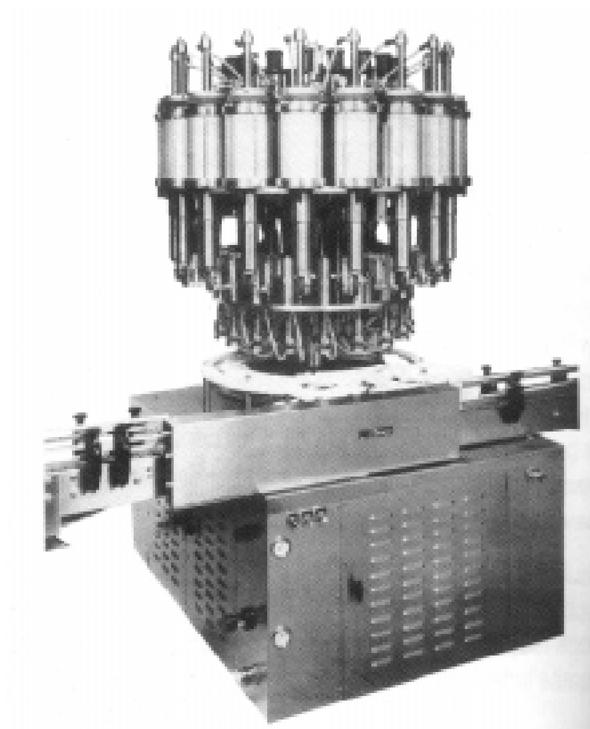
Background

Packserve, Thailand, initially used CFCs as aerosol propellants. In 1993, Packserve considered the conversion to hydrocarbon and decided upon Tarco of USA to provide the necessary technology. Using Terco's knowledge and the safety standards of the US Department of Transportation (DOT) and the National Fire Protection Agency (NFPA), a project was put together to implementation the building of the new Packserve facility.

Approach

Safety was the prime concern of the conversion. Pilot and small plants were made safe by enclosing the complete operation in an explosion-proof room. Medium and large plants required separate areas and integrated system control.

It was necessary to correctly guard the product filler, valve inserter and crimper to provide operator safety, as well as to provide proper ventilation. These

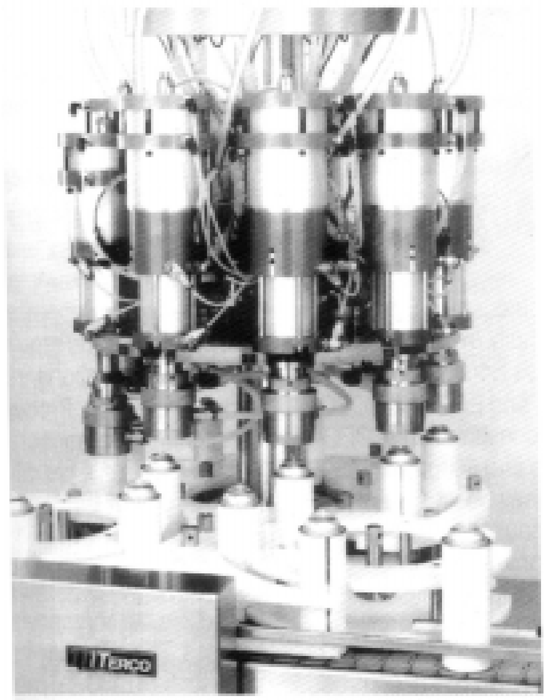


machines also ensure that the aerosol container is assembled to Chemical Specialties Manufacturing Association standards before entering the propellant gas filling area.

Safety precautions with respect to adequate ventilation, electrical equipment, static electricity, tools, materials, packing line equipment and ancillary equipment were taken. Rejected and unwanted aerosols were disposed of in a safe manner.

Lesson Learned

Since Packserve was the first plant to convert to hydrocarbon-based aerosol propellants in Thailand, it initially suffered a loss of sales, as it had to compete with other CFC users.



Rotary aerosol crimper

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Project 5 : **Eliminate the Use of CFC-12 in the Manufacture of Extruded Polystyrene and Polyethylene Foam**

Company : Associated Air-Pak Industries Sdn. Bhd

Location : Malaysia

Keywords

CFC-12, LPG, extruded polystyrene, Polyethylene foam, flammable

Summary

The project involved the successful conversion of CFC-12 to LPG in the manufacture of extruded polystyrene (EPS) and polyethylene (EPE) foam. Financed through the Multilateral Fund, UNDP provided assistance for acquiring the technology required for the conversion and the project was completed within nine months. The system has now been operating without any major problems for over three years.

Background

Associated Air-Pak Industries Sdn. Bhd., Malaysia, and its wholly owned subsidiary, Extro-Pak Sdn. Bhd., manufactured EPS and EPE using CFC-12, with an annual consumption of CFC-12 between 50 tons and 60 tons in 1992. Although the company was aware of the problems CFC-12 caused to the ozone layer, it could not commit the funds to a project that would not bring any monetary returns. In the early 1990s, when some customers demanded CFC-12-free foams, the company began to seriously consider the elimination of CFC-12 from its products. LPG was found to be a suitable alternative, which required modifications in-line and in-process. The company, however, possessed neither the financing nor the technology required for the conversion. In response, in 1993, UNDP offered to provide assistance in the conversion of CFC-12 to LPG.

Approach

The agreement for implementation was signed between the company and UNDP in December 1994. The costs for all equipment and technology transfers were provided by UNDP. The agreement also provided for the appointment of a process consultant who made several site visits and assisted with the identification and supply of various imported equipment. With his help, implementation problems were overcome. In-house technical and maintenance personnel coordinated the various suppliers and supervised the installation. Site visits were also made by UNDP staff to evaluate progress.

The use of LPG as a substitute required substantial changes in the production process and storage facilities. In response, the UNDP consultant recommended modifications and/or additions to storage, feeding, extrusion and electrical systems and auxilary safety devices.

The conversion project contained several safety features to address hazards generated by the use of flammable substances. For example, production areas had to be separated from other working areas, and required additional fire safety precautions, including sprinkler systems. Production and maintenance personnel also had to be trained in the safe handling of hydrocarbons.

Impact

The project achieved the elimination of CFC-12 in the company's production process. The company had used 50 tons to 60 tons of CFC-12 per annum at the time the project was planned and would have used two to three times that amount had the project not been implemented. The changeover to LPG resulted in improved product quality and reduced foam densities. LPG, being a cheaper blowing agent, also provided economic benefits.

Lessons Learned

Project planning included provision for safety measures needed for use of flammable gases.

Training of plant personnel in safe handling of hazardous gases added to the success of transfer of technology.

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Project 6	:	**Supply of Cyclopentane Technologies for Polyurethane Foam**
Company	:	Cannon Asia
Location	:	Singapore

Keywords

ODS, Polyurethane, cyclopentane, technology transfer

Summary

Cannon Urethane Technology, in cooperation with implementing agencies, has been actively involved in technology transfer in Asian countries, especially China. Cannon has supplied China with cyclopentane technology for polyurethane foam in the refrigeration sector, and has also undertaken a number of other projects in China, some of which have already been completed. Under the Multilateral Fund, Cannon also developed, supplied and transferred technologies to other Asian countries.

Background

Cannon has been the forerunner in supplying polyurethane technologies for the phasing out of ODS in close cooperation with all of the implementing agencies (UNDP, UNIDO and the World Bank) and the industries themselves. Technology from Cannon Asia has been transferred, besides, China to Philippines, Thailand, Malaysia, Indonesia and Vietnam.

Technology Transfer to China

In the refrigerator sector, China, being the most populous country and producing the highest number of refrigerators among the developing countries, is most active in phasing out ODS and in replacing them with cyclopentane.

In support, Cannon provided China with technologies including cyclopentane foaming machines and pentane and polyol premixing. It also provided engineering design and supply for a cyclopentane storage tank system, cyclopentane storage tank system, cyclopentane piping distribution system, enclosure and ventilation system for a wet and dry plant, and retrofitting of the existing wet and dry equipment from CFC-11 to cyclopentane. Safety controls, training and a monitoring and alarm system to ensure safe operations were also provided.

Key elements for success

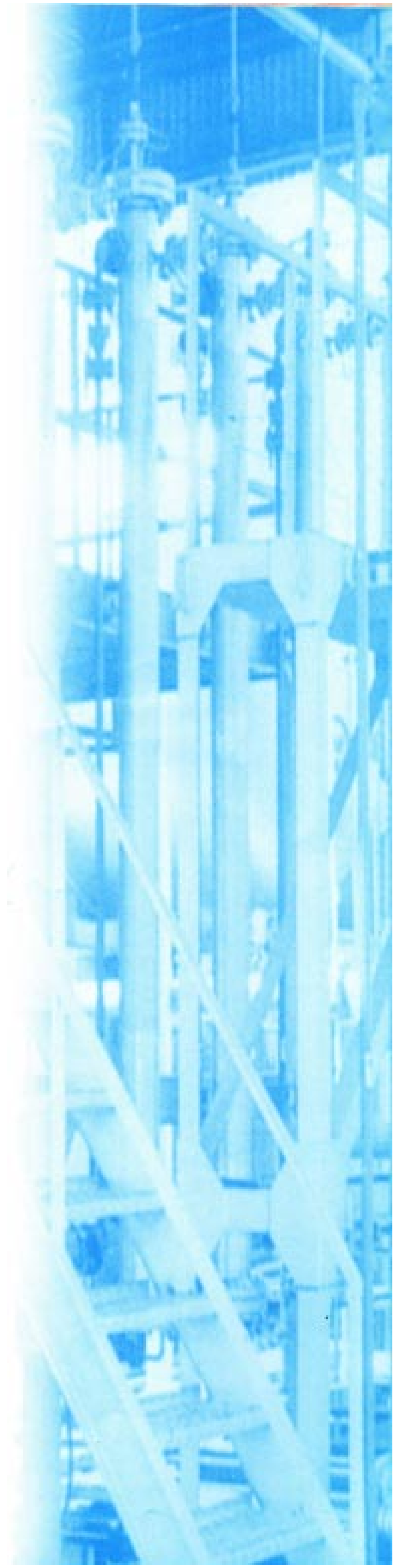
To ensure success of the projects, the key elements were:

- a well-engineered plant;
- a closely-followed schedule to ensure minimum disruption of production;
- all parties working closely to keep within budget;
- close cooperation among all parties involved;
- close cooperation among all parties involved;
- close supervision to ensure quality works and to meet all technical specifications;
- proper training of operators for safe operation and maintenance of the plant; and
- local technical support by the supplier.

Technology transfer to other developing countries

Cannon's research into alternative blowing agents began early at Cannon's Research & Development laboratories as soon as the Montreal Protocol called for a progressive phase-out of CFCs in 1987. Under the Multilateral Fund programme, Cannon has developed, supplied and transferred the following technologies to developing countries:

- Multi-Easy Froth – premixing of polyol with 141b, 134a, HCFC-22, cyclopentane, CO2, other HCFCs or HFCs;



- Cardio – CO_2 replacing CFC-11 or methylene chloride in continuous slabstock production;
- Cannoxide – premixing or direct CO_2 injection into mixing head for flexible or rigid foam application;
- Penta twin model of high-pressure dosing machines, specially designed for cyclopentane application for refrigerator and panel industries; and
- complete engineering, design, supply and installation of ventilation system and electrical safety control systems for refrigerator production using pentane as a blowing agent, in compliance with TUV standards.

During the execution of the technology transfer, Cannon worked very closely with the China Tender Board, Ministry of Environment, factories, subcontractors, implementing agencies (UNIDO, UNDP and World Bank) and TUV inspectors.

Lessons Learned

Close collaboration with the stake holders in the technology transfer were the crucial elements in the success of the project.

Working with developing countries to adopt the technologies to the local needs enhanced the effectiveness of the deployment of technology.

Polymer mixing unit

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Case Studies from International Agencies

The following three case studies present a selected set of experience of implementing agencies in Asia-Pacific developing countries in transferring non-ODS technologies under the Montreal Protocol. Implementing agencies of the Montreal Protocol's Multilateral Fund include UNIDO, UNDP, UNEP and the World Bank. The fourth case study presents experiences from a non-political development agency.

Study 1 : UNIDO

Background

UNIDO has played a lead role in promoting non-fluorocarbon technologies, particularly hydrocarbons and LCD. UNIDO's experience with technology transfer projects includes lessons learned from technology transfers, main challenges and barriers and recommendations on how to overcome barriers.

The typical project cycle of a UNIDO investment project comprises three main stages: project identification, project document formulation and approval and project implementation and monitoring. Within a project, the final choice of a new technology is the preorgative of recipient enterprises. However, before its submission to the secretariat, the choice is reviewed by an external technical reviewer to ensure that the technology is proven, viable, transferable, and cost-effective and will not have an unacceptable or adverse environmental impact.

From the UNIDO 1999 Business Plans, approved investment projects for ODS phase-out were in the following sectors:

- aerosol: 32 approved projects – mainly using hydrocarbon aerosol propellants;
- foam: 65 projects – methylene chloride and liquid CO2 for flexible foams and hydrocarbons for rigid foams;
- fumigant: 25 projects – substituting methyl bomide by alternative chemical and non-chemical methods, all combined with integrated pest management;
- halon: ABC dry chemical powder and foam water system have been chosen;
- refrigeration: 105 projects – the majority of investment projects approved use hydrocarbons. HFC-134a is another technology choice for domestic and commercial refrigeration. Ten percent of the approvals concern the servicing of refrigeration equipment; and
- Solvent: 31 projects – substituting CFC-113 and TCA by aqueous and semi-aqueous cleaning alternatives.

Lessons Learned

Technology is a composite of techniques and skills and one of the prime motive forces for development. Technology transfer allows for new access to advanced means of production and for better control over the means of production. The Montreal Protocol provides that the best available environmentally safe substitutes and related technologies are transferred to Article 5 countries and that the transfers occur under fair and favourable conditions.

Technology transfer under the Montreal Protocol provides for services to cover both software and hardware. These are supplemented with other activities such as installation, commissioning, trial operation, start-up and on-the-job training. A number of projects have been implemented and, wherever applicable, safety concepts were elaborated and third-party certificates were obtained.

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Study 2 : UNDP

Background

UNDP is one of the four implementing agencies helping developing countries fulfil their obligations under the Montreal Protocol. As of December 1998, UNDP had approved 909 projects in 65 countries, mostly financed by the Multilateral Fund with approvals totalling USD 220 million. An increasing number of countries with economies in transition (CEITs) are also being assisted by UNDP using funds from the Global Environment Facility (GEF) with approvals totalling USD 15 million. Throughout the implementation of the UNDP programmes, a significant amount of technology transfer was provided to recipient countries, mainly through investment projects for private and state enterprises that consume ODS.

In its work, UNDP:

- briefs national and international consultants on policy guidelines provides by the Executive Committee of the Multilateral Fund, the GEF Council and their respective secretariats:
- briefs new consultants on technology options recommended as mature by committees such as the TEAP and the sectoral TOCs;
- assists National Ozone Units (NOUs) to identify enterprises that consume ODS and to formulate strategies for phase-out in various ODS-consuming sectors;
- prepares annual reports and business plans that report progress made in ongoing technology transfer projects and plan such activities for the future;
- participates in ODS officer network meetings to discuss the technology transfer process with ODS focal points and other implementing agencies; and
- formulates project all projects formulated by UNDP, once approved by the Executive Committee. It is also the major driving force for the implementation of ongoing projects.

Lessons Learned

Difficulties encountered in the process of technology transfer under the Montreal Protocol can be separated under technological, cost and market concerns.

Technologically, the switch-over to alternative technologies may often have a nagative impact on the production process at the enterprise level and/or on the quality of the end product. Cost-wise, apart from some exceptions (i.e. aerosols, halons), alternatives to ODS-based technologies are more expensive because of required initial capital investments and higher operational costs. And market-wise, market conditions determine whether technology transfer will be implemented successfully or not.

To overcome the above, the right mix of incentives and disincentives should be put into place. Possible tools at the disposal of the government to encourage the process of technology transfer include:

- the Multilateral Fund/GEF grants for ODS-consuming enterprises;
- public awareness campaigns and eco-labelling programmes;
- government determination and follow-up;
- introduction of legislative measures tax codes;
- the setting of technical standards industry associations; and
- the introduction of local sales taxes on ODS-based equipment.

Furthermore, cooperation between all major stakeholders is essential for the successful implementation of technology transfer projects. Aside from implementing agencies, other major stakeholders include NGOs, which serve as information providers, national and international consultants, chemical suppliers, equipment suppliers, industry associations, the in-house technical departments of beneficiary enterprises commercial links with overseas companies and independent technology providers.

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Study 3 : UNDP

Background

UNEP's mandate under the Montreal Protocol, provided for under Article 10 (b), is to operate a clearinghouse function to assist developing countries by supporting global and regional information exchange, facilitating the sharing of experiences between countries through workshops and networking, and providing technical and policy training to enable implementation of the phase-out of ODS.

The activities of UNEP as one of the implementing agencies are designed based on the needs of the developing countries and the aim at creating enabling conditions for the successful compliance. The activities facilitate process of technology transfer at each step:

- why the ozone-friendly technology is needed: it is addressed through the awareness material about implications of depletion of ozone layer.
- what technology option are available: this question is responded through its technical sectoral booklets (6-volume seriees) and case-studies.
- how to assess and select an appropriate technology: through its sectoral technology source books and guide-books.
- how to implement and deploy ozone-friendly technologies: through training and training manuals, books on codes and practices, policy guidebooks and compilation of legislations.
- how to sustain the technology change: through the policy and monitoring workshops and networking with National Ozone Units.

Lessons Learned

UNEP devised a *participatory approach* where stakeholders were involved in the preparation of *Country Programmes* – a national blueprint for phasing out ODS. It helped in building trust, ownership of strategies and commitment to action plans, and engaged stakeholders in its implementation. It was also found that the participatory process selected for formulation was as valuable as the content of the programme.

Developing countries need to set up an *enabling infrastructure* for initiating implementation of multi lateral environmental agreement – the key requirement identified by the OzonAction Programme. Enabling tools such as awareness kits, self-help guides and contact databases were developed to allow governments to seek partnerships with industry, NGOs and the public to achieve their obligations to the Protocol.

The need for a *neutral information clearinghouse* is being fulfilled by the OzonAction Programme. Its main sources of information are the reports of the Technology and Economic Assessment Panels (TEAPs) and its sectoral Technology Options Committees (TOCs) that have experts from industry, technical and research institutes worldwide. Reports are put into simple and user-friendly languages that describe technical issues and alternative solutions to equipment and practices that use ozone-depleting substances.

Industries in developed countries were ahead of their partners in the developing countries in their phase-out strategies. Case studies of these successes, when disseminated to developing countries, often promoted partnerships between developed and developing countries, between governments as well as industries. *Recognition provided by UNEP to industries in developed countries has resulted in sustaining such cooperation and ensuring a continued sharing of experiences.*

Finally, the Bangkok workshop

emphasized that the programme's information clearinghouse function should increasingly emphasize interlinkages between the Kyoto and Montreal Protocols, including greater information dissemination and awareness-raising activities on cross-cutting issues. For this, it was observed that UNEP-TIE's regional networks could play a crucial role.

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Study 4 : Swisscontact

The agency

Swisscontact was established in 1959 in Zurich, Switzerland by members of the Swiss private sector and Swiss universities. A non-political and non-denominational development agency, Swisscontact obtains its support from the Swiss private sector and enterprises and associations, and collaborates with the Swiss Agency for Development and Cooperation. It also executes projects on behalf of international institutions and other bilateral donors and private organizations. Swisscontact operates in more than 20 developing countries, its projects being executed by 50 field staff and 150 local staff. Projects relate to the promotion of vocational education, crafts and industry, small-and medium-sized enterprises and urban ecology.

Swisscontact has been active in Indonesia since 1974 mainly in the field of vocational training. In 1990, it started the *Small and Medium Enterprise Promotion Project (SMEP),* which later expanded and incorporated activities in the refrigeration sector. Since 1996, Swisscontact has been supporting or facilitating the introduction of natural refrigerants or hydrocarbons in Indonesia. Today, these activities run under the *Cleaner Production and Services (CPS)* project.

Background

Indonesia was to stop the import of CFCs by the end of 1997. It was known that this would cause the price of CFCs to increase, making operations of existing equipment more expensive, and a complete lack of CFCs in the market would cause existing equipment to become inoperable. This was particularly problematic, because in developing countries like Indonesia, the lifetime of equipment is much longer than in developed countries as new investments are very expensive and access to credit is often difficult.

The ideal situation was therefore to keep the existing equipment running with recovered CFCs and hydrocarbons as drop-in refrigerants, thereby benefiting the users of equipment, the service sector and the environment. Fortunately, Indonesia had the potential to produce local hydrocarbon refrigerants, provide the market with expensive products in the long-run, and become less dependent on imports.

The service sector demanded 70 percent of the refrigerant supply, and much of it could be replaced by hydrocarbons, which made it attractive for producers and importers.

Experience with hydrocarbon refrigerants already existed with the Bandung Institute of Technology, but new projects were out of reach for financial reasons. Furthermore, R-134a was not a promising candidate for replacing CFC-12 as its price was five times that of R-12, it needed strict service procedures, and it was not always suitable as a drop-in.

Swisscontact and its partners had experience in the refrigeration sector from a project in Costa Rica in 1995 (Aptamai-HC Training). In response, taking advantage of the positive factors and taking care of risks with flammability, hydrocarbons as a substitute for ODS were introduced and safety was applied in pilot projects in the refrigeration service sector.

At the same time, the economic crisis in Indonesia helped promote hydrocarbon refrigerants, as buying new equipment and importing expensive alternative refrigerants was not feasible.

Project implementation

Swisscontact played a role in project design and in supporting and facilitating activities in the ODS/hydrocarbon field. Main partners included the local ministries of environment and trade and industry, universities, training institutions, technicians, industries and business people. Externally, universities, consultants, organizations in the ODS field and producers of hydrocarbon refrigerants were used.

The main activities of the project included training for the correct and safe application of hydrocarbon refrigerants, the promotion of hydrocarbon refrigerants as an economical alternative to other refrigerants, pilot projects, the import and production of hydrocarbon refrigerants and lobbying among government and other institutions for hydrocarbons.

Future activities include: continued training activities and pilot projects; similar ODS/hydrocarbon activities in the service sector of the Philippines and Sri Lanka; focusing on safety issues for conversions in the service sector for small as well as larger equipment; providing access to the Multilateral Fund in developing countries for technical training, institutional strengthening and equipment subsidies; developing more practical safety regulations for developing countries; and organizing seminars on ODS phase-out with a focus on solutions for the refrigeration sector.

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The Workshop

The workshop was **jointly organized** by the United Nations Asian and Pacific Centre for Transfer of Technology (UN-APCTT). the Centre for Science and Technology of the Movement for Non-Aligned States (NAM S&T) and the OzonAction Programme of UNEP's Technology, Industry and Economics (TIE) Division.

Representatives from both industry and government from 11 countries from the Asia-Pacific region participated in theworkshop. Countries included Australia, Bangladesh, India, Indonesia, Republic of Korea, Lao PDR, Malaysia, Philippines, Singapore, Thailand and Vietnam. Invited participants from Japan, Italy and the USA also participated in the workshop along with representatives from implementing agencies of the Multilateral Fund of the Montreal Protocol. The Multilateral Fund secretariat was represented by its Deputy Chief Officer.

The **criteria** for workshop participation included representatives of the following:

- National Ozone Units of participating countries;
- selected industries in countries which are recipients of Multilateral Fund assistance, and whose projects have already been completed; and
- implementing agencies and selected bilateral organizations.

The workshop was divided into *seven sessions (see agenda in Annex).* The first session covered general information about the Montreal Protocol and discussed how projects were approved and funded under the Multilateral Fund. Sections Two to Five each concentrated on case studies relating to experiences in technology transfer in specific ODS-using sectors in the Asia-Pacific region including: refrigeration and mobile air-conditioning (MACs); foam; aerosol and tobacco; and solvents. Section Six concerned lessons learned by implementing agencies in technology transfer. And Section Seven was a roundtable discussion on the successes and barriers of technology transfer.

The National Ozone Units of the participating countries presented *country papers* focusing on experiences in administering non-ODS technology transfer projects. *Case study* presentations were also prepared by industry representatives highlighting information as contained in an outlined provided to them prior to the workshop.

The activities that were agreed upon as a follow-up to this workshop included the following:

- attendance of a representative from this workshop to the IPC meeting in Pettern, the Netherlands;
- production of a proceedings of the workshop focusing on successes in the region, to be disseminated to a wider audience;
- preparation of more detailed information for the case studies which would be addedto the proceedings; and
- replication of such workshops at regional and national levels where substantial technology transfer activities have taken place.

It was also concluded that UNEP TIE's OzonAction Programme would follow up on the completion of these activities through its network of ODS Officers in the different regions, in cooperation with national and regional technology transfer institutions.

An evaluation was conducted at the end of the workshop through an evaluation questionnaire distributed to participants. The questionnaire focused both on the logistics and the substance of the presentations. In response, participants generally stressed the importance of such a workshop while recognizing that more time was neededto allow in-depth discussions of certain issues. It was found that the workshop contributedto the overall understanding of technology transfer in the region. Participants also agreed that it was good to understand the various problems faced by enterprises in transferring to new technologies.

WORKSHOP PROGRAM

LESSONS LEARNED AND CASE STUDIES FROM A TECHNOLOGY TRANSFER UNDER THE MULTILATERAL FUND OF THE MONTREAL PROTOCOL

ASIA-PACIFIC REGIONAL WORKSHOP

Organised by
The Asian and Pacific Centre for Transfer of Technology (APCTT) and
The Centre for Science and Technology of the Non-aligned and
other Developing Countries (NAM S&T Centre)

in cooperation with
The United Nations Environment Programme, Division of Technology,
Industry and Environment (UNEP DTIE)

BANGKOK, THAILAND, 1-3 MARCH 1999

1 MARCH 1999

9:00 – 10:00 Opening of Meeting

Key Note Address:
Mr Ogunlade Davidson, Co-Chair, Intergovernmental Panel on *Climate Change (IPCC) Working Group III*

Opening Statements:
Mr Rajendra M. Shende, *Chief, Energy and OzonAction UNEP DTIE*
Mr B.P. Dhakal, Officer-in-Charge, Industry & Technology Division, ESCAP
Mr K.N. Johry, Director, NAM S&T
Mr Surendra Shrestra, Officer-in-Charge,
Regional Office for Asia and Pacific Organisation
Mr N. Srinivasan, *APCTT*

Session 1: Plenary "Technology Transfer under the Multilateral Fund"

SESSION CHAIR: Mr Ogunlade Davidson

10:00 – 10:20 Technology Transfer under the Multilateral Fund
M Tony Hetherington, Deputy Chief Officer, Multilateral Fund Secretariat

10:20 – 10:40 **Coffee Break**

10:40 – 11:00 Technology Economics Assessment Panel's Role of Assisting A-5 Countries in Technology Transfer
Dr. Steve Andersen, *Co Chair, UNEP TEAP*

Session 2: Experiences in Technology Transfer in Refrigeration and MACs

SESSION CHAIR: Mr Rajendra Shende

11:00 – 11:30 Compressor Manufacture Conversion: From CFC-12 to HFC-134a
Mr Kamol Uplanond, *Kulthorn Kirby Ltd, Thailand and Representative, Japan* Electrical Manufacturing Associations (JEMA)

11:30 – 11:45 Natural Refrigerant as Alternative Technology: Hydrocarbons in Domestic Refrigerators
Ms Huang Xiao Chi, *Kelon Factory, China*

11:45 – 12:00	Hydrocarbons in Domestic Refrigeration in Indonesia ***Mr Manfred Egger,*** *Swisscontact, Switzerland*
12:00 – 12:15	Use of Hydrocarbons in Foam Blowing ***Mr Lee Meng,*** *Cannon Urethane Technology (Asia)*
12:00 – 12:30	Conversion to Hydrocarbons and HFCs: Experience in Small Display Commercial Refrigerators ***Mr Cayetano Ferreria,*** Transunion Corporation, Philippines
12:30 – 13:00	Open Forum
13:00 – 14:00	**Lunch**
14:00 – 14:30	ODS Phase-out for Domestic Refrigeration **Mr Fujimoto,** JICOP
14:30 – 15:00	Mobile Air-Conditioner: Aluminium Parallel Flow Condenser Technology **Mr Kuldeep Singh,** Pranav Vikas Ltd., India (MACs) and ARUP, Germany
15:00 – 15:30	Open Forum
15:30 – 16:00	**Coffee Break**

SESSION CHAIR: **Mr N. Srinivasan**

16:00 – 16:30	Phase-out of CFCs in the Manufacture of PUF Foam **Mr Gianmario Bossi,** Perros, Italy
16:30 – 17:00	CFC-free Foam Manufacture ***Mr Loke Yeong Soon,*** *Neico, Malaysia*
17:00 – 17:45	Open Forum
17:45 – 18:00	Summary of the Day's Discussions

2 MARCH 1999

Continuation of Session 3 (Foam Sector)

09:00 – 09:15	Phase-out of CFCs in the Manufacture of PUF Foam ***Mr Eddie Gallor,*** *RGC Foam, Philippines*
09:15 – 09:30	Retrofit of Low Pressure Foam Machines to HCFC-141b *Representative from Karya Cipta, Indonesia*
09:30 – 10:00	Open Forum
10:00 – 10:30	**Coffee Break**

Session 4: Experiences in Technology Transfer in the Aerosol and Tobacco Sector

SESSION CHAIR: **Mr T. Junchaya**

10:30 – 11:00	Conversion to Hydrocarbons in the manufacture of aerosol products **Mr Boonchai Surawuthipong,** Packserve, Thailand and Mr Neil Parkinson Terco, Australia
11:30 – 11:45	Use of Carbon Dioxide Process in Tobacco Fluffing *Representative, Fortune Tobacco, Philippines*
11:45 – 12:15	Open Forum

Session 5:	**Experiences in Technology Transfer in the Solvents Sector**
12:15 – 12:40	Not-in-kind Technology in Electronic Industry: No Clean *Malaysian Industry and Mr Christian Marque, Promosol France*
12:40 – 13:00	Open Forum
13:00 – 14:00	**Lunch**
Session 6:	**Lessons Learned by Implementing Agencies in Technology Transfer**
SESSION CHAIR:	**Mr K.N. Johry**
14:00 – 14:20	UNEP DTIE
14:20 – 14:40	UNDP
14:40 – 15:00	UNIDO
15:00 – 15:20	World Bank
15:20 – 15:50	**Coffee Break**
15:50 – 17:50	Open Forum
17:50 – 18:00	Summary of the Day's Discussions

3 March 1999

Session 8:	**Roundtable Discussion on the Successes and Barriers in Technology Transfer**
SESSION CHAIR:	**Dr. Steve Andersen**
09:00 – 10:00	**Discussion on Regional Technology Cooperation and Industry Leadership**
10:00 – 11:30	**Coffee Break**
10:30 – 12:30	Country Presentations by National Ozone Units
12:30 – 13:00	Discussion
13:00 – 14:00	**Lunch**
14:00 – 15:00	Continue Discussion
15:00 – 15:30	**Coffee Break**
15:30 – 16:00	Summary of Recommendations from the Workshop
16:00 – 16:30	Closing Ceremony

Bangladesh

Summary

The largest ODS consuming sector in Bangladesh is the aerosol sector followed by the refrigeration and air-conditioning (RAC) sector. The Government of Bangladesh has undertaken a number of projects for phasing out Ozone Depleting Substances (ODS), some with financial assistance from the Multilateral Fund. It has established an Ozone cell under the Department of Environment to carry out activities related to the ODS phase out program. Training programs for technicians involved in the handling of ODS have been planned and some training workshops have already been held. Emphasis has been laid on the recovery and recycling of ODS. As a result of these activities, the general public has become increasingly aware of the consequences of Ozone layer depletion and the demand for ODS free products is on the rise.

Background

Bangladesh is a signatory to a number of regional and international conventions and protocols; the 'Montreal Protocol on Substances that Deplete the Ozone Layer' is one of them. Bangladesh an Article 5 country, has also ratified its London and Copenhagen amendments in 1994 and 1995 respectively.

The total ODS consumption was 305.80 MT in 1995, 687.6 MT in 1996 and 914.4 MT in 1997. The largest ODS consuming sector is the aerosol sector consuming about 61% of the total ODS used in the country (1997 survey). This is followed by the refrigeration and air-conditioning sector with 2.3 million commercial and domestic refrigerators containing CFCs in use throughout the country (1997 survey).

Government strategies

A project titled 'Institutional Strengthening for Phase-out of Ozone Depleting Substances' had been undertaken in 1996 under MLF assistance. An Ozone cell, to carry out activities relatedto National Focal Point for ODS phase-out, was constituted within the Department of Environment in 1995. To advise the Government in implementation of the Protocol an inter-ministerial 'National Technical Committee on Ozone Depleting Substances' (NTCODS) was constituted.

Based on a reconnaissance study taken in 1993, a detailed country Program was prepared in 1994 and four project proposals were submitted to the Multilateral Fund (MLF) for their assistance.

The project 'Institutional strengthening for the Phase-out of Ozone Depleting Substances in Bangladesh' was completed in 1999. The second phase of the project has been submitted to UNDP for financial assistance. The following activities have been undertaken so far: data update survey on import and consumption of ODS for the years 1994-97; organization of seminars; exchange of information about alternative technologies; employment of consultants to evolve a policy and institutional framework for implementation and monitoring the Country Program; awareness campaigns etc.

Another project titled 'Conversion to CFC-free Technology in the manufacture of Aerosol Products' is being implemented by the Department of Environment and is expected to be completed by the first quarter of 2000 with the expected phasing out of 61% of ODS.

A one member Montreal Protocol Mission visited Bangladesh in 1997 to help formulate a new project on recovery and recycling at the national level. The Bangladeshi technicians have already developed an indigenous method for recovery and recycling. The Department of Environment will arrange necessary training for relevant technicians engaged in the service sector of refrigeration and air-conditioning.

Impact

The general masses have become significantly aware of the consequences of Ozone layer depletion. This is reflected in the increased tendency of buyers of air conditioners, refrigerators and insecticide aerosols towards ODS free devices. 20% of the imported refrigerators are CFC free. In case of recovery and recycling. 6% of ODS are now recovered by indigenous method.

With the above awareness, tendency and interest of various groups of people in the backdrop, a realization has been generated among concerned authorities of the Government to undertake projects designed to phase out ODS in the country and thus to contribute to global endeavor towards protecting the ozone layer.

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LAO PDR

Summary

There is no local production of ozone depleting substances in Lao PDR and the consumption is met through imports, with CFC-12 being the main chemical used in the refrigeration and air-conditioning sector (RAC). The Government has initiated the development of a country program and set up a Science, Technology and Environment Organization (STENO). This organization will deal with issues related to the environment until the Country Program is approved. An Ozone Unit is to be set up as the main link between ODS users and government agencies. At present the main task of the government is to inform the relevant agencies, relevant authorities and general public about the Protocol and implications.

Background

Lao PDR is a land locked country facing classic development challenges. The United Nations classifies it as a ‘least developed country’. The country has ample natural resources and agriculture is the livelihood for 85% of the people.

The Country is situated in a part of the world where economic development has been intense and is likely to spread to Lao PDR. Tourism is expected to increase. This means a greater demand for hotels and restaurants with air-conditioning, refrigerators and freezers.

Till date there is no local production of any ozone depleting substances (ODS) in Lao PDR. All consumption is met through imports, mainly from Thailand, Vietnam and China. Refrigeration and air-conditioning (RAC) sectors account for the greatest volume of ODS consumption in the country with CFC-12 being the main chemical used. It is used for servicing RAC units as well as in automotive air conditioning equipment and small amounts in flushing systems during repairs.

The Lao PDR acceded to the Vienna Convention for the protection of the Ozone Layer and the Montreal Protocol on Substances that deplete the Ozone Layer on 30 July 1998. These instruments came into force on 19 November 1998.

Government Strategies

The Government has currently initiated the development of the Country Program (CP) and a Refrigerant Management Plan (RMP) for the phasing out of ODS as the first step towards its short and long term obligations under the Protocol. The consultation has been undertaken with UNEP and FFEM, France through which technical and financial assistance is being requested.

Recognizing the increasing importance of science, technology and environment, the Lao government has created a specific organization responsible for these issues in 1982. In 1993, the organization was upgraded to become a part of the Prime Minister's Office and became the Science, Technology and Environment Organization (STENO). STENO has the mandate to set policy and regulatory framework, to set standards, to monitor compliance with policies and regulations and to coordinate environmental planning and management across all sectors.

STENO serves as the Focal Point with respect to the preparation of the Country Program and the RMP. It coordinates the implementation of all activities in the Action Plan of the CP and coordinates the formulation of projects under the RMP. It is involved in inter-ministerial and inter-departmental coordination for implementing administrative measures. It will take part in the gathering and dissemination of information on the Montreal Protocol issues, monitoring and reporting on ODS consumption and regulating imports of CFCs.

STENO will continue with Protocol matters until the Country Program and RMP are approved and will implement them in collaboration with the Ministry of Finance and Ministry of Trade, private sectors, non-governmental organizations and support from bilateral and multilateral funds.

An Ozone Units is to be set up which will be the main link between the users of ODS and the government agencies monitoring the imports of these substances. The reporting of consumption as obligated under the Protocol, ensuring that freeze and eventual phase-out dates of the use of the ODS within the time scheduled will be done by the Ozone Unit. This unit will execute data collection, technical training, public awareness and other necessary tasks.

Impact

As the country has become a party to the Protocol only recently, the STENO has the overall responsibility on al environmental issues. At present many other ministries and the general public are not aware of the Montreal Protocol and the Environmental effects of CFCs. Technical and financial assistance from the Multilateral and Bilateral funds is required to phase out ODS from the country. Hence any impact of the government efforts will manifest itself only after the Country Program is approved and implemented.

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INDIA

Summary

India is self sufficient in the production of CFCs and its per capita consumption of ozone depleting substances (ODS) is presently less than 3 grams. The country program of India aims to phase out CFCs with minimum economic dislocation. The Government of India has stressed upon the need of a network so that enterprises may have better access to information. The Multilateral Fund has approved a number of Indian projects for conversion to non-ODS technologies in the aerosol, foam, RAC, solvent and Halon sectors and some of these projects have been successfully implemented.

Background

India acceded to the Montreal Protocol on 17 September 1992. India's per capita consumption of Ozone Depleting Substances (ODS) is at present less than 3 grams and did not cross 20 grams between 1995-97 as against 300 grams permitted under the protocol. India is self sufficient in production of CFCs.

Government strategies

A detailed India Country Program (CP) for phase out of Ozone Depleting Substances (ODS) was prepared in 1993 to ensure the phase out of ODS according to the national industrial development strategy, without undue burden to the consumers and the industry and for accessing the Protocol's Financial Mechanism in accordance with the requirements stipulated in the Montreal Protocol.

The main objectives of the country program have been to minimize economic dislocation as a result of conversion to non-ODS technology, maximize indigenous production, give preference to one time replacement, emphasize decentralized management and minimize obsolescence.

India has also been submitting projects for conversion to non-ODS technology in various sectors to the Multilateral Fund (MLF) and so far 187 projects have been approved.

The Government emphasizes on the need of a network so that enterprises of different sectors can get better quality information about equipment installation, operation and maintenance. This meant that the technology adopted would be more effective in the local environment.

Impact

The MLF has till date approved 13 Aerosol projects for conversion from CFC-12 to Hydrocarbon Aerosol Propellants (HAP) in the small and medium size industries. For the small and tiny industries a demonstration project for the conversion of five small aerosol filling installation to manual filling equipment using HAP has been approved by ExCom.

In the foam sector a total of 97 projects have been approved, including one group project involving 80 small manufacturers. Projects involving conversion to non CFC alternatives have been approved for the foam types: flexible PUF slabstock, flexible PUF molded, rigid PUF general insulation, thermoware, integral skin, thermoplastic and phenolic foam.

The RAC sector uses ODS for both foam as insulation and as a refrigerant. CFC-11 was used as the foam blowing agent earlier. Cyclopentane was chosen as an alternative to this for the large organized industries while HCFC 141b was the deliberate choice for the unorganized sector, even though it had residual ODP, due to safety considerations.

The choice of arefrigerant for small and medium scale entrepreneurs was HFC 134a. Larger producers who can manage adequate fire protection measures are yet to decide between hydrocarbon and HFC 134a technology.

For the selection of an alternative in the solvent sector a small-scale pilot study is essential to study the cost effectiveness of the chosen alternative. In some cases water/de-ionized water with or without additive like detergent may be a good choice while for some projects anhydrous isopropyl alcohol may be used.

Proper alternatives to Halon 1211 and 1301 are yet to be developed. The alternatives available at the moment do not match the efficacy and cost effectiveness of the two Halons. India therefore took the conscious decision not to go for untried alternatives but fall back on well tried ABC powder and carbon dioxide as the alternative Halon substitutes, even though they are inferior to Halons. However, some recent developments using carbon dioxide in a more efficient manner are taking place.

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INDONESIA

Summary

Indonesia imports all its domestic requirements of Ozone Depleting Substances (ODS). The Government of Indonesia has carried out a number of activities to phase out ODS in Indonesia. It has received assistance from the Multilateral Fund to aid it in its endeavours. The government proposes that the technology transfer should be implemented according to the size of the industry. At present HFCs and HCFCs are in use as CFC alternatives. These are to be replaced by hydrocarbons.

Background

Indonesia does not produce any Ozone Depleting Substances (ODS), all demand being supplied by imports from developed/developing countries. The consumption of ODS in 1997 was 2.177 MT. HFCs and HCFCs as interim alternatives have been used since 1995. Indonesia has received financial assistance from the Multilateral Fund to phase out ODS consumption through the implementing agencies i.e. UNDP, UNIDO and The World Bank.

Government strategies

The Government has conducted a number of activities since 1992, such as: seminars and campaigns to raise awareness, formulating and establishing regulations, training of service engineers, and implementing phase out activities including retrofitting and replacement of ODS uses in many sectors.

The ODS using industries are divided into the big, medium and small sectors. The government proposes that the technology transfer should be implemented according to the size of the industry as follows:

- For the big industries non-ODS equipment as a substitute for the existing one should be given, training should be imparted to the engineers as well as a trial run conducted.

- For the medium scale industries the substitute non-ODS equipment should be similar to the existing one (i.e. automatic or semi automatic) and training should be imparted to the engineers for using the materials and machines safety.
- For the small-scale industries supporting equipment (i.e. fire extinguishers, safety equipment, etc.) should be supplied, training imparted to the employee in charge of the production process and reformulation and trial runs conducted.

Impact

The CFC alternatives being used at present are HCFCs and HFCs. Hydrocarbons are being promoted as future alternatives. A lot of information is required for the implementation of hydrocarbon alternatives.

Activities which have not yet been adequately implemented are: recovery, recycling and retrofitting for Mobile Air conditioning and the Commercial Air conditioning sector.

Recommendations

- There should be a differentiation between the small and large-scale industries in requesting the fund.
- For the small-scale industries, a more applicable technology training in simple methods is required. It can be made cost effective it conducted for a group of industries at a time.
- The technology transfer should make use of domestic resources to the maximum.

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KOREA

Summary

Korea showed a very high consumption of ozone depleting substances (ODS) at the time of signing the Montreal Protocol. The Korean government imposed controls on the production and import of ODS in order to comply with the phasing out schedule. It set up a supporting fund to enable industries and research institutions to find and implement ODS alternatives. Korea successfully developed its own technology for the production of CFC alternatives. Non ODS replacements have been introduced in a number of sectors and efforts are going on to find replacements for HFCs which have a high global warming potential.

Background

Korea joined the international program of phasing out the (ODS) by signing on the Montreal Protocol in 1992. At that time, the consumption of ODS in Korea already exceeded the level for the Article 5 countries. However the situation of Korea made it difficult to comply with the phasing out schedule of the article 2 countries. Korea made much effort and successfully reduced the consumption down to the acceptable level in 1993, and was grouped in the Article 5 countries with the declaration of not using the Multilateral Fund (MLF).

Government strategies

In order to comply with the phasing out schedule, Korean government has been controlling the production and import of ODS. The target for the ODS phaseout is set at 2010 and the control level should be set in 1999 and 2000 for CFCs and Halons, respectively, as average consumption during 1995-97. The detailed control plan for each ODS is provided every year, on the basis of the overall control schedule, in consideration of the consumption in the preceding year and the required demand in the coming year.

Since Korea was not supported by the MLF, a supporting fund was established by imposing dues on ODS sold in Korea. The fund is being used for loan to industries for replacing CFCs by technology development, technology transfer, changing appliances, or other efforts. It is also being used for supporting research projects for the production of CFC alternatives.

Impact

The Koreans government's efforts have resulted in a significant reduction in the use of ODS. ODS refrigerants are being replaced by HCFC-22 and HFC-134a. HFC-134a is being used in most car coolers, while CFCs are still being used in most refrigerators and air conditioners for domestic use. Recently LG, one of the biggest producers of household electric appliances in Korea, declared that they would replace all the CFCs with non-CFC alternatives in their new products in 1999. It is expected that other producers will follow LG sooner or later. CFC used as a solvent was replaced by water, hydrocarbons or non-solvent processes. The foaming agents are being replaced with HCFC-141b, water, n-pentane or c-pentane. However the rate of reduction is not satisfactory as compared to the other application areas. Most spraying agents were replaced by hydrocarbons. In the fire extinguishing sector ODS are being replaced by a mixture of HCFCs or a mixture of inert gases.

Along with ODS replacement in the application areas, much effort was also made for the production of CFC alternatives. Korea developed its own technology to produce CFC alternatives instead of technology transfer from developed countries. Most research projects were carried out by the CFC Alternatives Research Center in the Korea Institute of Science and Technology (KIST) with the support of the government and industries. The first stage of the project was carried out in 1991-96 with the aim of developing the manufacturing process for the most probable CFC alternatives, HFC-134a, HFC-125, HFC-152a, HFC-32, HCFC-22 and HCFC-141b/142b. Basic design of the commercial plant was also developed. HCFC-22 and HCFC-141b/142b are now being produced commercially since 1996, while others have not been commercialized as yet due to low demand and international oversupply. The developed technologies were filed as patents in Korea, Japan, USA and UK.

The second stage of the research project began in 1997 with the aim of finding alternatives zero ODP and zero GWP alternatives to HFCs.

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MALAYSIA

Summary

A major portion of Malaysia's consumption of CFCs comes from the refrigeration sector. The Government of Malaysia established the National Steering Committee (NSC) to formulate a strategy to reduce the use of CFCs and Halons. The Government's Country Program aims to reduce consumption of CFC and Halons by setting a phase-out date. A number of activities and programs were carried out to promote global effects to reduce ODS consumption. Recovery and recycling of CFCs was encouraged and administrative measures implemented to discourage CFC imports. Between 1989 and 1997 it has successfully reduced ODS consumption by almost 50% per capita with most of the industries having converted to CFC-free technologies. This was mainly due to the policies and strategies adopted by the NCS. However, to achieve a complete phase-out of ODS there are still many challenges that must be overcome.

Background

The Department of Environment (DOE) in Malaysia is the national focal point for coordinating, monitoring and implementing all Montreal Protocol activities including ODS phase-out investment project. Malaysia acceded to both the 1985 Vienna Convention on the Protection of the Ozone Layer and the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer since August 1989. Subsequently, Malaysia ratified the London Amendment (1990) on 5 August 1993 and Copenhagen Amendment (1992) on 3 November 1993.

In 1997, the total import of ODS was 7,962 MT. The consumption of CFCs was 3,351.48 MT (0.15 kg/capita). More than 75% was from the refrigeration and air-conditioning sector (RAC) and 19% from the foam sector. The efforts taken in eliminating ODS have resulted in a reduction from 0.29 kg per capita in 1989 to 0.15 kg in 1997.

Government strategies

Following ratification of the Protocol, the National Steering Committee (NCS) for the Protection of the Ozone Layer was established to formulate a strategy and plans to reduce the use of CFCs and Halons. The ODS Technical Committee, ODS Industrial Working Groups and Ad Hoc Committee were also established under the NCS. The Government prepared its own Country Program in 1991. It put into place a detailed plan to phase-out CFC and Halon by the year 2000.

The policies and strategies of the NSC aim for the following: to discourage further investments relating to the production and use of CFCs and Halon; to encourage existing industries to develop and use substitutes and to change their ODS-dependent processes as soon as possible; to promote voluntary compliance on reduction and phase-out before Protocol target dates; to monitor the use of ODS; to participate in international conventions and meetings to contribute effectively so as to achieve the objectives of the Protocol; and to promote joint public awareness compaigns by "Malaysia Incorporated Concept" with industries and suppliers.

The Environmental Quality Order 1993 that entered into force by June 1994 prohibits the use of any controlled substances in any manufacturing process, trade or industry of aerosol.

CFC will still be in use in service sector such as for mobile air-conditioning units and building chillers beyond the year 2000. Recovery and recycling of CFCs coupled with retrofiting program will be promoted to reduce consumption and ultimately phase-out CFC in this sector before 2010.

The following activities and programs were carried out: ODS consumption surveys; the Country Program to eliminate CFCs and Halons; ODS phase-out programs by Industrial Working Groups; stategies for protection of the ozone layer; review of the CP; control measures such as guidelines and regulations prohibiting the use of CFCs and Halons; series of publications produced and disseminated to public and industries; and ODS phase-out projects and public awareness campaigns.

To meet the 1999 Freeze, administrative measures have been introduced to discourage the import of CFC products and to avoid dumping of technologies.

The Environmental Quality (Refrigeration Management) Regulations will be introduced to control new installations of chillers, venting of refrigerant and requirement of approved training in handling reclamation and recycling. A Halon Bank was established to collect decommissioned Halon for critical users in future. A new regulation to ensure Halon phase out and avoid illegal trading will be introduced.

Problems faced

Consideration by the Parties of adjusting the developed country control provisions relating to HCFC will also influence the possibility of controlling the use of HCFC in developing countries particularly Malaysia which is one of the major exporters of the split air-conditioning systems. Millions of dollars have been invested to substitute CFC with HCFC. The intention of Parties to control the use of Methyl Bromide which, though used in insignificant amounts in Malaysia, may have indirect impacts on commodity products.

Impact

The on going implementation of the first phase of the controlled substances is very satisfactory. Most of the industries have converted to non-CFC technologies with a 90% reduction in the solvent and aerosol sectors. By the end of 1999 the reduction in the foam sector is expected to be 80%. The use of CFCs is still allowed in RAC and the user is encouraged to use recycling during maintenance and servicing.

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SINGAPORE

Summary

In Singapore, the Ministry of Environment (ENV) has the overall responsibility for the legal framework and policies to curb the use of ozone depleting substances (ODS). The Government has undertaken a series of measures to control the supply and use of ozone depleting substances. Various government agencies participated in this coordinated strategy. The tender and quota allocation system introduced by the Government has helped in successfully phasing out CFCs. Programs and schemes introduced by the Productivity and Standards Board (PSB) helped Singapore achieve a quick transition from CFC to non-CFC technologies.

Background

Singapore became a party to the Montreal Protocol on Substances that Deplete the Ozone Layer in April 1989 after becoming a signatory to the Vienna Convention for the Protection of the Ozone Layer in December 1988. It ratified the London Amendment in March 1993.

Government strategies

Singapore adopted a multi-pronged strategy to discharge her obligations under the Montreal Protocol. The Ministry of Environment (ENV) has the overall responsibility for the legal framework and policies to curb the use of zone depleting substances (ODS). Other agencies like the Trade and Development Board (TDB), the Productivity and Standards Board (PSB) and the Economics Development Board (EDB) along with the ENV implemented market-based and voluntary programs to manage the use of ODS.

The control measures adopted by the government include the following: Quota allocation sytem for fluorocarbons; prohibition of the import and manufacture of non-pharmaceutical aerosol products and polystyrene products containing CFCs; prohibition of the use and import of Halons and Halon containing fire extinguishers; prohibition of the import of HCFCs, CFCs, Cabron Tetrachloride and Methyl Chloroform and; all new cars to be equipped with non-CFC air-conditioners.

The tender and quota allocation system was formulated to effectively reduce the consumption and ultimately phase out the use of CFCs. Importers, industrial end-users, distributors and re-exporters of CFCs and Halons are required to be registered and licensed by TDB. Allocations were set for both public tenders and distribution according to consumers' historical consumption data. The public tender requires interested parties to register and submit bids for their desired CFCs and quantities along with prices they are willing to pay. Quotas were given to the highest bidders, but te actual prices were pegged at the lowest successful tender price. This resulted in maximum quantities being allocated to those companies willing to pay the most but at a price that would avoid uncessary economic burden. Unsuccessful companies were allotted a quantity based on a pro-rated share of their previous years' consumption or distribution of the controlled CFCs.

The TDB offered tax and financial benefits to small-and-medium-sized enterprises who were reluctant to convert to alternative technologies, to assist them with the required modifications to their equipment and production processes to conserve CFCs or switch to substitutes.

Impact

The tender and quota allocation system led to a significant rise in CFC pricing, creating strong incentives for recycling, conservation and transition to alternatives. A Technical Assistance and Information Dissemination Program was put into place by PSB. This program assisted companies in exploring non-CFC alternatives through technical consultancy services and dissemination of information on sourcing of alternatives. PSB also had an ODS-Free Process Verification Scheme to provide third party certification for companies in Singapore.

It was through such programs and schemes that Singapore was able to achieve a relatively fast transition from CFC to non-CFC technologies. Singapore's experience demonstrated the effectiveness of market-based and voluntary approach to the phasing out of CFC.

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Summary

Vietnam has decided upon the import of technology in order to aid socio-economic development. The imported technology is required to meet certain minimum standards. Though Technology transfer is playing an important role in the modernization and industrialization of Vietnam it had to face a number of challenges in implementing a market economy.

Background

Vietnam which is experiencing a surge in socio-economic development attaches special importance to technology transfer from abroad. It realizes that the development of any new technology requires considerable investment in terms of capital and time. Therefore in order to facilitate faster socio-economic growth it has decided upon the import of technology.

Government strategies

Concerning ozone layer protection, the imported technologies into Vietnam are required to meet the following minimum standards:

1. New technology should not include ODS and should be safe for the environment in general.
2. New technology should correspond to the technology and scientific levels of Vietnam.
3. New technology should assure economic reforms.
4. New technology should meet the labor safety standards and preserve the health of employees.

To ensure that technology transfer is effective in aiding economic growth and sustainable development in Vietnam, the government must address the following issues:

1. Formulate a long-term program for selecting technologies suitable for Vietnam.
2. Promulgate suitable finance,

credit, foregin currency, customs, policies, etc.

3. Perfect system of state managed technology transfer and technical development in accordance with the current economic structure and international rules.

Impact

The Government of Vietnam affirms that technology transfer is playing an important role in industrialization and modernization of Vietnam. In the next 5-10 years, technology transfer in Vietnam will mostly come from a stream of foreign investment.

However, the challenges that Vietnam has faced in technology transfer while implementing a market economy over the past 10 years has been as follows:

- Technology and equipment came into Vietnam from any countries with different economic and technological standards. This lead to diversified and unequal levels of technology.
- Most technologies that are imported by way of investment are of the average standard in the investor country even including out of date and old technologies. This results not only in the hampering of production but also environmental destruction.
- The technology market is limited. It is therefore impossible to select from a wide range of technologies.
- The duration of technology transfer is limited and hence Vietnam is unable to absorb the new technology fully thus making it totally dependent on its supporters.

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1. Opening Statement: Lessons Learned from Technology Transfer under the Multilateral Fund of the Montreal Protocol - *Dr Ogunlade Davidson, Co-Chair, Intergovernmental Panel on Climate Change (IPCC) Working Group III*
2. Opening Statement: Rajendra M. Shende
3. Technology Transfer under the Multilateral Fund *Mr Tony Hetherington, Deputy Chief Officer, Multilateral Fund Secretariat*
4. Technology Economics Assessment Panel's Role of Assisting A-5 Countries in Technology Transfer *Dr. Steve Andersen, Co Chair, UNEP TEAP*
5. Conversion of Compressor Manufacture from CFC-12 to HFC-134a *Mr. Kamol Uplanond, Kulthorn Kirby Ltd, Thailand*
6. Hydrocarbons in Domestic Refrigeration in Indonesia *Mr Manfred Egger, Swisscontact, Switzerland*
7. Technolgoy and Experience in CFC Phase out Programme *Mr Lee Meng, Cannon Urethane Technology (Asia)*
8. Conversion to Hydrocarbons and HFCs: Experience in Small Display Commercial Refrigerators- *Mr Cayetano Ferreria, Trans-Union Appliance, Philippines*
9. Experience in Technology Transfer in Refrigeration and MACs: Aluminium brazed Parallel Flow Condenser Technology - *Mr Kuldeep Singh, Pranav Vikas, Ltd., India (MACs)*
10. ODS Phase-out for Domestic Refrigerators *Mr Fujimoto, JICOP*
11. Phase-out of CFCs in the Manufacture of PUF foam *Mr Gianmario Bossi, Perros, Italy*
12. A Case Study: Experiences in Technology Transfer in the Foam Sector *Mr Eddie Gallor, RGC Foam Philippines*
13. Retrofit of Low Pressure Foam Machines to HCFC-141b *Representative from Karya Cipta, Indonesia*
14. Project to Eliminate the Use of CFC-12 in the Manufacture of Extruded Polystyrene and Polyethylene Foam- *Air-Pak Industries Sdn Bhd, Malaysia*
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16. Not-in-kind Technology in Electronic Industry: No Clean *Malaysian Industry and Mr Christian Marque, Promosol France*
17. Lessons Learned in Technology Transfer (UNEP TIE)
18. Lessons Learned in Technology Transfer (UNDP)
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About the UNEP Division of Technology Industry and Economics (DTIE)

The mission of the UNEP Division of Technology, Industry and Economics is to help decision-makers in government, local authorities, and industry develop and adopt policies and practices that:

- are cleaner and safer;
- make efficient use of natural resources;
- ensure adequate management of chemicals;
- incorporate environmental costs; and
- reduce pollution and risks for humans and the environment.

The UNEP Division of Technology, Industry and Economics (UNEP DTIE), with its head office in Paris, is composed of one centre and four units:

- The International Environmental Technology Centre (Osaka), which promotes the adoption and use of environmentally sound technologies with a focus on the environmental management of cities and freshwater basins, in developing countries and countries in transition.

- Production and Consumption (Paris), which fosters the development of cleaner and safer production and consumption patterns that lead to increased efficiency in theuse of natural resources and reductions in pollution.

- Chemicals (Geneva), which promotes sustainable development by catalysing global actions and building national capacities for the sound management of chemicals and the improvement of chemical safety world-wide, with a priority on Persistent Organic Pollutants (POPs) and Prior Informed Consent (PIC, jointly with FAO).

- Energy andOzonAction (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition, and promotes good management practices and use of energy, with a focus on atmospheric impacts. The UNEP/RISƒ Collaborating Centre on Energy and Environment supports the work of the Unit.

- Economics and Trade (Geneva), which promotes the use and application of assessment and incentive tools for environmental policy and helps improve the understanding of linkages between trade and environment and the role of financial institutions in promoting sustainable development.

UNEP DTIE activities focus on raising awareness, improving the transfer of information, building capacity, fostering technology cooperation, partnerships and transfer, improving understanding of environmental impacts of trade issues, promoting integration of environmental considerations into economic policies, and catalysing global chemical safety.

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About the UNEP DTIE OzonAction Programme

UNEP

Nations around the world are taking concrete actions to reduce and eliminate production and consumption of CFCs, halons, carbon tetrachloride, methyl chloroform, methyl bromide and HCFCs. When released into the atmosphere these substances damage the stratospheric ozone layer – a shield that protects life on Earth from the dangerous effects of solar ultraviolet radiation. Nearly every country in the world – currently 172 countries – has committed itself under the Montreal Protocol to phase out the use and production of ODS. Recognizing that developing countries require special technical and financial assistance in order to meet their commitments under the Montreal Protocol, the Parties established the Multilateral Fund and requested UNEP, along with UNDP, UNIDO and the World Bank, to provide the necessary support. In addition, UNEP supports ozone protection activities in Countries with Economies in Transition (CEITs) as an implementing agency of the Global Environment Facility (GEF).

Since 1991, the UNEP DTIE OzonAction Programme has strengthened the capacity of governments (particularly National Ozone Units or "NOUs") and industry in developing countries to make informed decisions about technology choices and to develop the policies required to implement the Montreal Protocol. By delivering the following services to developing countries, tailored to their individual needs, the OzonAction Programme has helped promote cost-effective phase-out activities at the national and regional levels:

Information Exchange

Provides information tools and services to encourage and enable decision makers to make informed decisions on policies and investments requiredto phase out ODS. Since 1991, the Programme has developed and disseminated to NOUs over 100 individual publications, videos, and databases that include public awareness materials, a quarterly newsletter, a web site, sector-specific technical publications for identifying and selecting alternative technologies and guidelines to help governments establish policies and regulations.

Training

Builds the capacity of policy makers, customs officials and local industry to implement national ODS phase-out activities. The Programme promotes the involvement of local experts from industry and academia in training workshops and brings together local stakeholders with experts from the global ozone protection community. UNEP conducts training at the regional level and also supports national training activities (including providing training manuals and other materials).

Networking

Provides a regular forum for officers in NOUs to meet to exchange experiences, develop skills, and share knowledge and ideas with counterparts from both developing and developed countries. Networking helps ensure that NOUs have the information, skills and contacts required for managing national ODS phase-out activities successfully. UNEP currently operates 8 regional/sub-regional Networks involving 109 developing and 8 developed countries, which have resulted in member countries taking early steps to implement the Montreal Protocol.

Refrigerant Management Plans (RMPs)

Provide countries with an integrated, cost-effective strategy for ODS phase-out in the refrigeration and air conditioning sectors. RMPs have to assist developing countries (especially those that consume low volumes of ODS) to overcome the numerous obstacles to phase out ODS in the critical refrigeration sector, UNEP DTIE is currently providing specific expertise, information and guidance to support the development of RMPs in 60 countries.

Country Programmes and Institutional Strengthening

Support the development and implementation of national ODS phase-out strategies especially for low-volume ODS-consuming countries. The Programme is currently assisting 90 countries to develop their Country Programmes and 76 countries to implement their Institutional-Strengthening projects.

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The Centre for Science & Technology of the Non-aligned and the Other Developing Countries was set up in 1989 as a follow-up of the recommendations made by the Heads of the States of the Non-aligned Movement (NAM Summits) at their meetings held at Colombo (1976), Havana (1979) and New Delhi (1983). The Centre with its headquarters at New Delhi (India) has 39 countries from Asia, Africa and Latin America as members at present.

The Centre aims to promote the fullest possible and mutually beneficial collaboration among scientists regarding technological capabilities of the Non-aligned and other developing countries with a view to promote technological cooperation, transfer of technology, etc. among them, stimulate and promote joint research and development projects and training programme.

The Governing Council of the Centre has laid down the areas of priority and programmes for the Centre which at present cover bio-technology including tissue culture and medicinal plants, environment, renewable energy, micro-electronics, telecommunication, remote sensing, human settlement etc. A number of programmes are under way in these areas and a number of publications have been brought out and are being brought out the quarterly NAM S&T Newsletter. The Centre has organised jointly with UNEP, regional workshops on ODS phase-out in SMEs and also brought out its proceedings. The Centre has close working cooperation with other international S&T organizations and specialized UN agencies including, UNIDO, Commonwealth Science Council, Third World Academy of Sciences, Asian and Pacific Centre for Transfer of Technology, Asia Pacific Telecommunity, WAITRO, COSTED, GBF of Germany, AIT and ASEAN-COST.

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Congo	Peru
Colombia	Sri Lanka
Cuba	St. Lucia
Cyprus	South Africa
DPR Korea	Syria
Egypt	Tanzania
Ethiopia	Togo
Gabon	Uganda
Guyana	Vietnam
Indonesia	Yugoslavia
India	Zambia
Iraq	Zimbabwe
Lebanon	

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Asian and Pacific Centre for Transfer of Technology (APCTT)

APCTT

The Asian and Pacific Centre for Transfer of Technology (APCTT) is a regional institution of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). It was established in 1977 with the objective of facilitating technology transfer in the Asia-Pacific region. Its programs are coordinated with national focal points designated by the governments in member countries.

APCTT has two main areas of activities, namely: (a) Development activities to strengthen technological capabilities and technology transfer networking in Asia and the Pacific and (b) technology transfer services to facilitate business contracts among client enterprises. With its focus on environmentally sound technologies (ESTs) for sustainable development and small and medium scale enterprises (SMEs), the Centre: (1) brings out periodicals and publications that are read in over 70 countries; (2) updates on a daily basis its databank on international technology and business opportunities; (3) develops networks and partnership among technology transfer intermediaries; (4) organizes workshops and training programmes on technology transfer services, technology assessment, evaluation and pricing; (5) provides international matchmaking services and organizes business meets and technology missions; (6) develops mechanisms and services to deliver ESTs to SMEs in Asia and the Pacific; and (7) works towards the environmentally sound economic development of the region.

Development Activities

APCTT implements national and regional development projects through the following areas: (1) Technology Information and Transfer for SMEs by organizing training programs on service development, pricing and marketing for technology intermediaries; developing networks; and undertaking studies on technology information and transfer mechanisms; (2) Technology Management by organizing workshops on commercialization of R&D results, technology assessment, evaluation and pricing; (3) Environmental Information and Management by developing EST information, transfer and delivery mechanisms and services for SMEs; and organizing EST transfer business meets; and (4) Women in Development by facilitating the exchange of technology information and technical training for women.

Technology Transfer Services

APCTT provides SME-oriented technology transfer services in the following area:
(1) Information on technology opportunities and new technological developments; (2) Search for and matching of prospective technology transfer partners; (3) Support services (market studies, feasibility studies, assistance in contract negotiations); and (4) Finance syndication and marketing assistance for technology transfer projects.

Apart from its website, APCTT services may be accessed by

- visiting the APCTT Information Centre;
- availing of APCTT international technology transfer match-making service for technology buyers and sellers;

- subscribing to SME-oriented business periodicals (Asia Pacific Tech Monitor, Catalogue of International Technology and Business Opportunities);
- joining INTET-Asia to get timely updates on international technology offers and requests and
- subscribing to the Value Added Technology Service (VATIS) Updates on technology trends in the areas of Biotechnology, Food Processing, Non-Conventional Energy, Ozone Layer Protection, and Waste Technology.

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