Department of Economic and Social Affairs

Business

and the

United Nations

Partners in Sustainable Development

INDUSTRY AND TECHNOLOGY

Based on case studies of technology transfer exhibited at the sixth session of the Commission on Sustainable Development (20 April - 1 May 1998)

United Nations
New York, 1999

A large number of people and organizations contributed to the Industry and Technology Exhibits and Presentations, held during the sixth session of the Commission on Sustainable Development (20 April - 1 May 1998), and to the preparation of this publication.

Acknowledgements

The United Nations Department of Economic and Social Affairs, and its Division for Sustainable Development, extends its thanks to the co-sponsoring organizations: the United Nations Environment Programme (UNEP), the United Nations Development Programme (UNDP) and its Public-Private Partnerships for the Urban Environment (PPP) Programme, the United Nations Industrial Development Organization (UNIDO), and the Canadian International Development Agency (CIDA). Without the substantive and financial contributions of those organizations,
the project would not have been possible.

Credit for the substantive content of the exhibits goes to the participating enterprises and to the Governments and industrial associations which contributed to make their participation possible: the Environment Ministry of Italy, the United Kingdom's Department of Trade and Industry, the International Chemical Association (CEFIC), the European Wind Energy Association, and the Iron and Steel Industry Association. The UNIDO contribution also included support for the participation of partner enterprises in developing countries.

Recognition should also be given to all those who shared their knowledge and experience through the presentations organized in conjunction with the exhibits: Richard Ackerman (World Bank), Jacqueline Aloisi de Larderel (UNEP IE), Charles Arden-Clark (WWF), Christopher Bell (ISO TC-207), David Bennet (Canadian Labour Congress), Frank Bill (Danish EPA), Laura Edwards (GWP), Bruno Fierro and Max Taverna (Cannon Group), Geoffrey Heal (Columbia University), Harris Gleckman (UNCTAD), Ralph Luken (UNIDO), Michael Massey (UK/TPI), Ron Michalek (WEC), Jim Oatridge (Severn Trent plc), Kristin Pierre (USEPA), Rolf Sagesser (FIDIC), Eberhard Seifert (Wuppertal Institute), and Geoff Smith (UK/JEMU).

Thanks also to Denise O'Brien for her enthusiastic support in the development of the exhibits, and to the staff of the United Nations Exhibits Committee, Meeting Services Section, Facilities Management Division and the Department of Public Information (DPI) of the United Nations for their cooperation and support in organizing the exhibits.

The Industry and Technology Exhibits and Presentations were organized and managed by Tarcisio Alvarez-Rivero and Theresa Olvida. This publication was compiled and edited by Mr. Alvarez-Rivero and Ms. Olvida, with the guidance of Ralph Chipman.

Note:

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers.

United Nations publication
Sales No. 98.II.A.2
ISBN 98-1-104482-0

CONTENTS

PREFACE

A central factor in achieving sustainability in business and industry is the improvement of production processes through the introduction of technologies that use resources more efficiently and minimize environmental impacts. If such cleaner production technologies are to be widely adopted without costly regulations, they must be cost-effective and fit into normal business decision making. The purpose of the Industry and Technology Exhibits and Presentations organized during the sixth session of the Commission on Sustainable Development (CSD) was to examine, through case studies, the process of transfer of cleaner production technologies from enterprises in developed countries to enterprises in developing countries.

While a number of terms have been used to describe technologies that increase the efficiency of resource use while reducing environmental impacts, including environmentally sound technologies and eco-efficiency, this publication uses the concept of cleaner production. This usage does not imply a rejection of the other terms, but reflects the language used in most of the case studies in the exhibits.

The cleaner production concept includes making more efficient use of energy, water and other materials in both processes and products, and minimizing waste and emissions at their sources rather than treating them after they have been generated. By reducing the costs of energy, water, materials and waste management, cleaner production can offer a better return on investment than other production processes. Cleaner production can also improve the quality of products. A growing number of case studies demonstrate both the economic and environmental benefits of cleaner production.

Efforts are being made by Governments, international organizations and industry to disseminate knowledge about cleaner production and its benefits. This publication explores the motivations of companies involved in nine cases of successful transfer of cleaner production technologies to enterprises in developing countries. These companies presented their stories during the Industry and Technologies Exhibits and Presentations.

Part I offers a summary of the case studies, focusing on the motivations and incentives facing the enterprises in both developed and developing countries. It also considers the lessons that may be drawn from these case studies as to how wider dissemination of cleaner production technologies can be promoted.

Part II presents the case studies as written by the companies themselves and edited to ensure consistency in their presentation. Also included is a description of the Internet Café, an initiative of the United Nations Environment Programme (UNEP) Industry and Environment office, in cooperation with the United Nations Industrial Development Organization (UNIDO) and the United Nations Conference on Trade and Development (UNCTAD). The Internet Café demonstrated the work of those agencies along with private sector partners in providing information on cleaner production opportunities to potential investors and governments.

Part III describes the organization of the exhibits and selection of participants.

Part IV contains background documents relating to technology transfer prepared for the sixth session of the Commission on Sustainable Development.

Part V contains the official United Nations documents of the sixth session of the Commission on the themes of transfer of environmentally sound technologies and industry.

The United Nations Division for Sustainable Development of the Department of Economic and Social Affairs, as well as its partners, the United Nations Development Programme (UNDP), UNEP, UNIDO and the Canadian International Development Agency (CIDA), hope that this publication will assist decision makers, public and private, in assessing and promoting cleaner production opportunities.

PART I: OVERVIEW OF THE CASE STUDIES

This chapter summarizes the experiences of the companies that participated in the Industry and Technology Exhibits during the sixth session of the United Nations Commission on Sustainable Development. It focuses on the motivations and decision-making processes involved in these nine examples of investments in cleaner production, taking into account both the incentives for the decisions and the obstacles to such investments in day-to-day corporate decision making. It examines the decisions from the standpoint of both the sellers and the buyers of the technologies.

These successful examples of technology transfer generally resulted in more efficient use of raw materials, producing economic benefits for the companies concerned as well as environmental benefits. This raises the question of why many enterprises, particularly small and medium-sized enterprises in developing countries, do not take advantage of such technologies, and how they might be encouraged to do so.

The purpose of this analysis is not primarily to encourage enterprises to transfer cleaner-production technologies, although that would be useful, but to examine the elements that guided the decision making processes of the companies in the case studies in order to shed light on how governments and international organizations can promote such transfers through information dissemination, facilitating access to capital, encouraging environmental management and accounting, and using environmental regulations to promote cleaner production.

It will not always be the case, of course, that reducing pollution will provide net economic benefits to the enterprises concerned. Nevertheless, policies and programmes for promoting transfer of cleaner-production technologies can reduce costs in such cases and can be complemented by financial assistance for the investments or regulations that require them.

Factors promoting technology transfer by suppliers

For companies from developed countries selling their technologies, the incentives are clear. They make money by selling their technologies, and developing countries offer new markets. The costs of developing new and uncertain markets can, however, be substantial.

Consideration of the technology suppliers in the case studies suggests factors that motivated and enabled these companies to find companies in developing countries interested in cleaner-production technologies. Specific incentives and motivations vary among the case studies, but a number of factors can be identified.

- Domestic markets in developed countries are often very competitive, making growth in sales difficult to achieve. This may be a motivation for companies such as Thermoselect (waste treatment) and Bono Energia (biomass energy) to find developing country outlets for their technologies.

- Investments in research and development of cleaner-production technologies may be of such magnitude that large international markets and sales are needed to absorb these costs and keep prices at competitive levels. This may be the case for Vestas (wind energy), Cannon (CFC substitutes) and Thermoselect (waste treatment) in that their technologies are for specific industrial processes and thus have a limited market in each country. The limited market also means that potential customers are relatively easy to identify.

- Some products and processes have natural markets in developing countries. This is the case with the biomass cogeneration plants (Bono Energia) and gold mining technologies (mt Metall-Technic GmbH). While the biomass cogeneration plants have had some success in developed countries, the market is quite limited,

and developing countries may provide better opportunities. In the case of the gold mining technologies for the informal artisanal sector, the domestic market in developed countries is virtually nonexistent, and developing countries are the primary market.

- The costs to developed country enterprises of identifying and working with customers in developing customers can be reduced through the mediation of international development programmes such as those of United Nations agencies. The UNEP/UNIDO Cleaner Production Centre in Mexico brought Hoogovens Technical Services of the Netherlands (steel production) together with Acerlan in Mexico, providing assurance to both partners of the credibility of the other. The 11 UNEP/UNIDO Cleaner Production Centres in developing countries also assist in the evaluation of cleaner-production opportunities and the transfer of the technologies.

- The increasing awareness of technology suppliers of the opportunities offered by international environmental agreements and the mechanisms for their implementation is an additional motivation to seek developing country markets. Such is the case for Cannon (CFC and VOC substitutes) with respect to the Montreal Protocol on the protection of the ozone layer and its Multilateral Fund, and Safety HiTech (greenhouse gas substitutes) with respect to both the Montreal Protocol and the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. Safety HiTech, a multi-national company based in Italy, identified an important market for halon-substitute technologies in India as a result of that country's commitment to phase out halons by the year 2010. Safety HiTech worked with North American Fire Guardian of Canada and its Indian office to explore the demand in India for its products following their acceptance as an acceptable product for halon replacement by the Halon Alternatives Committee of India. Futher development of implementation mechanisms for the Kyoto Protocol and other international environmental agreements should provide further opportunities for clean technology suppliers to offer their products and services in developing country markets.

Factors promoting cleaner production in developing countries

The difficulties facing developing-country enterprises, particularly small and medium-sized enterprises, are more complex. The case studies illustrate a number of factors influencing investment in cleaner production.

- Environmental regulations may impose requirements for cleaner production processes. In the case of the fishmeal producers in Chile, impending new regulations created the need to reduce water pollution from production operations. The cleaner production technologies not only enabled these plants to comply with the new standards, but also improved efficiency in the production process, making operations more profitable.

- Other companies were motivated by the efforts of their governments to comply with international commitments. In the case of the foam producers in Argentina, the Argentine Government promoted the technologies to reduce CFC and VOC emissions and address concerns for workers' health and safety. The Argentine Government and UNDP, in selecting cleaner production technologies and obtaining funding through the Montreal Protocol's Multilateral Fund, played an essential role in the transfer process. The decision-making process of the companies involved was greatly simplified by the work of the Government and UNDP.

- In the case of Kisan and Daewoo Corporations and their purchase of solid wastetreatment technology from Thermoselect, the decision-making process entailed more complicated choices. The motivation for this decision seems to be two pronged: (a) the participation of the Seoul municipal government in the venture assured the corporations of contracts for the management of municipal solid waste; and (b) the new technology enabled the corporations to operate their facilities in a more environmentally sound way, preparing them for the inclusion of the Republic of Korea into the OECD. An agreement was reached to license the Thermoselect technology to Kisan and Daewoo rather than to sell the facilities for two reasons. First, the plants could be produced cheaper in the Republic of Korea than in Europe and quality control would

be close to the customer. Second, market development for further technology transfer would be easier if production of the facilities were done locally, taking advantage of existing manufacturing capacities of both Kisan and Daewoo. This type of technology transfer, including full acquisition of know-how and manufacturing capability, follows the technology policies of the Republic of Korea. This may have provided additional motivation for these companies in choosing to implement the transaction through a licensing agreement.

- Government policies also played a significant role in the decision of the Comision Federal de Electricidad (CFE), Mexico's government-owned power supplier, to purchase wind energy technology from Vestas in Denmark. By deregulating the electricity sector, the Mexican Government opened the doors for the participation of private companies in the energy sector. In particular, the new policy allowed Entec to enter into a build-lease-and-transfer (BLT) agreement with CFE. This turn-key agreement, for which Entec, through the United States venture capital firm New World Power, provided the capital, allowed for repayment of the loan through annual payments by CFE from wind farm revenues. This agreement reduced the risk for Entec while allowing the state-owned utility access to private capital.

- A number of the developing country enterprises received support from international development agencies. While enterprises such as Acerlan (Mexico), the fish processing plants (Chile), artisanal gold mines (Tanzania), foam producers (Argentina) and S.V.V. Engineering Industries (India) might have implemented cleaner production investments without the assistance of UNIDO, UNDP, UNEP and the Montreal Protocol Multilateral Fund, the participation of these international partners clearly facilitated these investments. The agencies were instrumental in obtaining for these companies terms and conditions better than those available in open markets. They provided technical expertise and improved information for decision making in dealing with the complexities of installing, adapting and managing new technologies to improve productivity while reducing pollution.

The case involving chrome recovery and reuse for the leather tanning industry in India illustrates how United Nations agencies can contribute to changing production processes throughout a national industrial sector. In this case, UNIDO identified an influential local partner in S.V.V. Engineering Industries, India. Through this company, UNIDO was able to achieve extensive dissemination of the cleaner technology in an important sector of the Indian economy. Success in this case was based not only on the qualities of the technology transferred, but also on the ability of UNIDO and its partners to create a sizable market for that technology in India.

In the case of the Chilean fish processing companies, as well, UNIDO ensured effective coordination of technology from various suppliers in several countries. Under pressure from the government to comply with new water pollution standards, the companies contacted the Universidad de Concepcion, which put them in contact with UNIDO. Under UNIDO's programme for promoting sustainable industrial development, a thorough assessment of the environmental impacts of the production process was made and the technological requirements for alleviating these impacts were identified. UNIDO, along with its Chilean partners, identified the proper technologies and coordinated their purchase and installation. UNIDO's knowledge and experience in international transactions and in identifying appropriate technologies in a global market were essential to the successful transfer of cleaner technology.

In the case of the transfer of CFC- and VOC-substitute technologies to the Argentine plastic and foam industry, the United Nations Development Programme (UNDP) and the United Nations Office for Project Services (UNOPS) mediated between the technology suppliers and users.

The transfer of clean production technology for steel making to Acerlan and the redesign of its foundry process would probably not have taken place without the assistance of the UNEP/UNIDO Cleaner Production Centre in Mexico. The Cleaner Production Centre undertook a thorough evaluation of the production processes of the foundry and prescribed a series of cleaner production alternatives to the production

operations. The assistance of the Cleaner Production Centre provided assurance to Acerlan that the changes prescribed were appropriate and made business sense.

Promoting broader transfer of cleaner production technologies

The preceding summary of the case studies from the Industry and Technology Exhibits identifies a number of factors than can effectively promote transfer of cleaner production technology to enterprises in developing countries. The case studies also suggest that many investments in cleaner production technology are not being taken in the absence of special motivating factors, even when they produce an attractive return on investment.

The state of the environment in many developing countries, particularly those undergoing rapid industrialization, clearly indicates that there is a great need for cleaner technologies. Promoting the transfer of technologies that offer economic as well as environmental benefits, while not solving all of the environmental problems of developing countries, can address many of the problems and promote sustainable development. It is therefore useful to examine the factors that promote transfer of cleaner production technologies and consider how they can be expanded and strengthened to promote broader transfer of such technologies.

The potential for strenthening and expanding the motivations for technology transfer depends on the specific nature of each situation. Some of these motivations were project-specific, for example assistance from a UNEP/UNIDO Cleaner Production Centre, while others applied to all enterprises in a particular industrial sector, for example national environmental regulations. Some motivations were technology- and sector-specific, such as the Montreal Protocol and its Multilateral Fund for the phase-out of ozone-depleting substances, while others would apply to a broad range of technologies and sectors, such as the programmes of international organizations for transferring cleaner production technologies and the Kyoto Protocol on greenhouse gas reduction.

There is substantial potential for expanding and strengthening the work of international organizations in promoting and assisting the transfer of cleaner production technologies. Currently, there are UNEP/UNIDO National Cleaner Production Centres in fifteen countries, including six in Latin America, three in Africa, three in Asia, and three in Eastern Europe. In addition to project assistance, those Centres provide training, disseminate information and provide policy advice. Other technical assistance programmes of UNEP, UNIDO, UNDP, the Division for Sustainable Development, the World Bank and other international organizations also provide assistance for the transfer of cleaner production technologies. Funding for such projects is available through those programmes and through the Global Environment Facility, which funds projects managed by UNDP, UNEP and the World Bank. Many bilateral technical assistance programmes also support the transfer of cleaner production technologies.

International agreements provide motivations for both developed and developing countries to promote the transfer of cleaner production technologies. The International Framework Convention on Climate Change and its Kyoto Protocol, the Vienna Convention on the Protection of the Ozone Layer and its Montreal Protocol, the Convention on Biological Diversity and the Convention to Combat Desertification all contain provisions for technology transfer and financial assistance to developing countries in meeting the objectives of the agreement. Of these agreements, only the Montreal Protocol has its own funding mechanism in the Multilateral Fund, while financial assistance in the other areas is available through the Global Environment Facility. The elaboration and implementation of the provisions of the Kyoto Protocol, in particular the Clean Development Mechanism, should provide further motivations for countries to promote the transfer of cleaner production technology to developing countries. However, global funding mechanisms of this sort specifically directed at cleaner production are likely to be available only for global problems such as protection of the ozone layer and global climate change.

In terms of international commitments by developing countries, the Montreal Protocol commits developing-country parties to phase out CFCs and other ozone-depleting substances by 2010. The United Nations Framework Convention on Climate Change commits them to "promote and cooperate in the development,

application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases", without any targets or deadlines.

National environmental regulations and other policies in developing countries can provide broad and effective motivations for enterprises to seek cleaner production technologies to comply with existing and foreseeable standards. However, Governments in developing countries are often reluctant to enforce regulations that would close enterprises or limit industrial development and economic growth. Nonetheless, some of the more industrialized developing countries, as illustrated by the case studies from Chile and the Republic of Korea, are increasingly concerned with environmental protection and cleaner production. To the extent that environmental regulations and policies can be designed to promote the transfer of available clean and resource-efficient technologies, they can promote both cleaner production and economic growth. Economic policy instruments such as pollution and emission charges can also be used, perhaps with the revenues used to support the installation of cleaner technologies. Such economic instruments could further increase the profitability of investing in cleaner production.

The ultimate objective should be to make resource-efficient and clean production the norm in all countries through the use of a range of policies and mechanisms, including national policies, international technical and financial assistance, international trade and investment, research and development, and information dissemination. Enterprises would then, as standard business practice, seek out technologies for reducing raw material inputs and waste output. National and international technical and financial assistance could concentrate on introducing the latest advances in cleaner production into the market through information dissemination and demonstration projects.

While most of the case studies involve investments motivated, at least in part, by environmental considerations, the transfer of wind energy technology to Mexico and biomass cogeneration to Nigeria were company-to-company transactions intended solely to address traditional business concerns of cost reduction, improved efficiency in production, increased profitability and expanded market share.

One obstacle to investment in cleaner production is the lack of recognition of the economic benefits of such investments, due in part to the widespread assumption that environmental protection is expensive. Promoting the use environmental accounting at the enterprise level would help to identify cleaner production investments offering high rates of return. The case studies in this publication, like much of the literature in the field, focus on identifying the environmental benefits and provide little quantification of the return on investment or other financial benchmarks reflecting internalization of environmental costs. The development and dissemination of simple environmental accounting systems would help enterprises determine whether an investment in cleaner production meets their benchmark for rate of return on investment, taking into account access to capital and alternative investment opportunities.

Through the use of environmental accounting, companies can assess the financial relationship between environmental factors and production processes, including natural resource inputs and product and waste outputs. Environmental accounting systems provide a framework for the identification, collection, analysis, interpretation and communication of the financial information needed by management to plan, evaluate and control the use of resources and the disposal of waste. They provide a tool for understanding the full spectrum of costs of existing production processes and the economic benefits of cleaner production and to integrate those costs and benefits into day-to-day business decisions.

The United Nations' Division for Sustainable Development, in cooperation with the United States Environmental Protection Agency, DG-III (Industry) of the European Commission, UNEP's Division of Technology, Industry and Economics and UNCTAD have initiated a series of international expert meetings to explore ways in which governments can effectively and efficiently promote the development and use, by business on a voluntary basis, of environmental management accounting systems.

Conclusion

The case studies presented in this publication provide examples of motivations and incentives to companies to transfer cleaner production technology to developing countries. In most of these cases, the incentives were part of efforts by United Nations agencies, in some cases with funding under international environmental agreements, and were intended as demonstration projects to show the economic and environmental benefits of cleaner production. While such internationally assisted projects should continue, they are too limited in resources and scope to address the broad range of sustainable development issues facing developing countries. Sustainable development requires that cleaner development become an integral part of national development strategies.

Efforts must be made to expand the availability of financing at preferential terms for companies choosing cleaner production investment options both from multilateral sources as well as national and local sources. UNEP's Division of Technology, Industry and Economics, in cooperation with several United Nations agencies and other international organizations, is engaging in the project "Strategies and Mechanisms for Promoting Cleaner Production Investments in Developing Countries". This project, set to start in 1999, is intended to demonstrate, in selected developing countries, how the international community and the financial sector can promote and support financing of cleaner production investments in both new and existing industrial facilities.

Such initiatives could help to shift the scale of the transfer and dissemination of cleaner production technologies from the present level of demonstration projects to the level of national policies, complemented by international policies and programmes, covering whole industrial sectors. International support for cleaner production can then be progressively focused on the most critical and difficult areas and the most advanced clean production technologies.

At the national level, regulatory approaches mandating cleaner production can be supplemented by economic instruments which provide direct incentives for cleaner production while generating revenues to reduce the costs of introducing the new technologies and maintaining industrial growth rates and competitiveness. Such economic incentives will also encourage enterprises to evaluate the economic benefits of more resource-efficient production, thus integrating environmental factors into routine corporate decision making.

New environmental accounting procedures, both managerial, for internal company use, and financial, for external reporting, may assist corporate decision makers in evaluating the costs and benefits of cleaner production investments.

If consideration of cleaner production options is to become part of routine enterprise decision making, it will be essential to disseminate information on cleaner production technologies and services through traditional business information channels. The international community, including United Nations agencies, is making efforts to improve the global dissemination of information on cleaner production technologies.

Traditional business approaches and the cleaner production approach are increasingly being integrated, particularly in developed countries. To promote this integration, the United Nations Commission on Sustainable Development has been actively working to increase the role of industry in its work, as illustrated by the Industry and Technology Exhibits and Presentations and this publication.

In promoting the goal of more sustainable global industrial systems, the United Nations, Governments and the international community must expand their cooperation with the business community. The United Nations is committed to remaining partners with industry in sustainable development.

PART II: CASE STUDIES

1. ARTISANAL GOLD MINING

Companies	Artisanal gold mines
City / Country	Tanzania (UNIDO and mt Metall-Technic are introducing or planning to introduce the technology in more than 50 countries)
Industry sector / Description of products	Equipment and technologies for sustainable artisanal gold mining
Support organizations or companies	mt Metall-Technic GmbH, Vaterstetten, Germany, with the United Nations Industrial Development Organization (UNIDO)
Other lessons learned	Based on established procedures for gold mining, ThermEx raises the income of miners while protecting their health and the environment.

Contact Information	mt Metall-Technic GmbH Zugspitzstr. 28A D-85591 Vaterstetten Germany ☎ +49 8106 8930 ✆ +49 8106 893 500 Mr. Siegfried Sinner Dr. Matthias Kleine metall-technic@t-online.de

Description of process

Gold is found in concentrations from 4 to 30 grams per ton of raw ore. In artisanal gold mining, ore is usually milled manually. The gold particle size ranges from less than 30 to 100 μ, i.e., it is invisible to the naked eye. Only a few percent of the gold particles in the raw material are visible and are, therefore, separable by the use of tweezers.

Water and/or wind separate large amounts of lighter mineral material and enrich the substrate to which mercury is then added. Mercury reacts easily with many other metals and acts as a metal collector, forming amalgams. The contact between mercury and gold particles is achieved through mixing. Mercury incorporates the gold particles, forming an amalgam whose components can be easily separated.

Strong heating of the amalgam evaporates the mercury, leaving the gold. The heating is done in open pots, on blades or spoons. The mercury goes into the atmosphere, water and soil, and is transported through food chains. Miners and their families breathe the mercury vapors, the most dangerous form of mercury intake other than skin contact.

Gold losses result from spattering during the burning process, from the incrustation of amalgam in other metallic surfaces like pans and shovels, as well as in retorts of antiquated design. Gold losses also result from manipulating small beads and from "gold-dragging" by mercury vapor. All these losses may sum up to

12% especially if the amalgam is burned in small batches. These losses are well known to the "small-miners".

Description of technology acquired and/or changes in production processes

The ThermEx technology increases gold yield and reuses the mercury with no emission into the environment. The increased yield provided the motivation for the artisanal gold miners to adopt the new technology.

The distillation of mercury and its recovery through cooling in a closed system is physically very simple. For this, mt Metall-Technic GmbH has developed a safe, handy and maintenance-free retort called Therm-Ex which is especially designed for the needs of small-scale miners. The device yields up to 12% more gold for the miners and prevents the emission of mercury into the environment.

ThermEx is made of special glass and stainless steel and equipped with high temperature gaskets. Serviceability and fluid tightness were proved by independent experts. To overcome the obstacle of blackbox effects, which is common to antiquated retorts, the new design applies special see-through materials. The dimension and weight of the device make it suitable for artisanal use in frequently changing places.

Why was this technology chosen and what were the deciding factors

The use of mercury to collect gold is age-old. A substitute for mercury in goldmining is, even in the long run, not in sight. Applying up-to-date technologies make the use of harmful mercury possible without endangering health or the environment.

A see-through vessel for amalgam-burning guarantees the shortest possible operation time because no energy needs to be supplied for warming up large metal parts. No blackbox effects arouse uncertainty of gold vanishing in the machine. Discoloration of the gold, as often occurs in other retorts, is prevented by the proper selection of materials. Encrustation of gold on the retort is prevented by the use of special glass. The gold can easily be gathered from the vessel.

Improvements achieved (economic, environmental or others)

ThermEx technology increases the income of the miner because it avoids any gold-loss by spattered amalgam or by the gold being carried along with the mercury vapor. Furthermore, the recovered and re-used mercury, which contains traces of gold, is more active in amalgamation than pure mercury. This further increases the amount of gold recovered.

There is actually no emission of mercury from the amalgam-burning in this new retort, as verified by a German independent institution (TUV), i.e. 100% of the mercury is recovered when using ThermEx. The yields tend to be the optimum that can be reached in artisanal mining. Other processes, like cyaniding, are prohibited because of their acute toxicity. The problem of acceptance of this new retort by artisanal miners was subject to discussion from the very beginning of planning and construction. This led to a special choice of materials and to minimized dimensions and weight of the device.

Special conditions or assistance received

ThermEx was developed in cooperation with UNIDO and was accepted after detailed testing. Fruitful discussions with UNIDO experts as well as information interchange with other institutions led to a unique design which already has been named "a new dimension of retort" (Jennings, ILO). ThermEx was exhibited at UNIDO, Vienna, and at the Special Session of the United Nations General Assembly, 23-27 June 1997, New York (Earth Summit + 5). The retort is used by UNIDO for teaching and training purposes in Tanzania.

2. GREENHOUSE GAS SUBSTITUTES

Company Name	North American Fire Guardian, India PVT LTD.
City / Country	Madras, India
Industry sector / Description of products	Fire fighting Fire extinguishing agents - substitutes for Halons
Description of technology acquired and/or changes in production processes	Fire extinguishing materials Fire fighting system design
Support organizations or companies	Safety HiTech, Rome, Italy
Other lessons learned	India is a critical testing ground for the implementation of the Montreal Protocol on protecting the ozone layer. Acquiring the National American Fire Guardian's environmentally sound technology may be an important turning point in developing countries' commitment to the Protocol and compliance with the Halon phase-out date of 2010.

Contact Information	The Trinity I Floor, Kandigai Road, Korattur Madras 600 076 India -OR- Gianluca Indovino, 44 Viale Gino Cervi 1-00139 Rome, Italy ☎ +39 6 8713 4421 ✆ +39 6 8713 26830 ✇ G.Indovino@Mbox.it.net

Description of process

Safety HiTech, based in Italy, and North American Fire Guardian, based in Canada, have developed a range of eco-friendly extinguishing agents to replace Halon 1211 and 1301 in fire protection systems under the Montreal Protocol.

The products are popularly known under the trade names NAF S III (total flooding agent) and NAF PIV (streaming agent). These products have low environmental impact on the environment in terms of ozone depletion, global warming and atmospheric lifetime.

The technology and engineering already developed enable these products to be used beneficially with existing Halon systems with only minor modification, as well as in new installations. Today, there are already more than 15,000 installations worldwide, including several retrofittings.

Description of technology acquired and/or changes in production processes

In Italy, together with the "Consortium Environment and Safety for Halon Disposal", Safety HiTech has collected, in only six months (September 1997 - February 1998), 200 tons of Halon 1301 for destruction. In terms of ozone depletion, this quantity means 2,400 ozone depletion potential (ODP) tons. At the end of the campaign, around 8,000 tons of Halon 1301 and 9,000 tons of Halon 1211 will be collected, with emission savings of over 140,000 ODP tons.

The cost of the agent and system modification is the lowest of any of the other alternatives to Halon, and this technology is the least disruptive system for the replacement of existing Halon 1301 systems. The use of NAF products and their associated technology could be important in developing countries (Article 5). The technology has been successfully transferred to a number of Article 5 countries, and one of the important beneficiaries is India.

Why was this technology chosen and what were the deciding factors

Success has already been achieved with NAF systems installed in high value facilities including telecommunications control rooms and computer installations in some of India's major companies. NAF is now being specified for other government projects, petrochemical plants, power generating companies, etc.

India is one of the most critical Article 5 countries in terms of population and consumption of ozone depleting substances, and therefore, is an important testing area for the implementation of the Montreal Protocol. The HAOC (Halon Alternatives Committee, India), sponsored by the Government, has already evaluated the NAF products for use in India, recognizing their closeness to Halon 1301 and 1211 for fire extinguishing efficiency and low cost of retrofitting as well as for new installations, as well as low space requirements compared to other systems.

The installation of NAF S III would be advantageous in one or more of the following circumstances:

- When an inert, electrically non-conducting medium is essential or desirable;
- When the clean-up of a medium would present a problem;
- When weight or space is an important factor;
- When there is difficulty in ensuring the safety of personnel.

The extinguishing performance and low toxicity, together with low environmental impact, make the use of NAF agents particularly suitable for the following hazardous situations: computer and equipment rooms, electrical switch gear control rooms, chemical laboratories, military vehicles, aircraft engines, cargo and passenger compartments, microwave relay stations, flammable liquid storage or process areas, telephone exchange areas, transformers and conventional or nuclear plants, radioactive "caves" and hot cells, archive storage.

Improvements achieved (economic, environmental or others)

By transferring the NAF technology, a significant contribution is being made to the commitments made by Article 5 countries to the Montreal Protocol and the Kyoto Protocol. India is also planning to advance the phasing out of Halon by about 10 years in non-critical areas.

NAF S III systems have already been installed in India in high-value facilities including telephone companies and cement factories. NAF S III is the most cost-efficient replacement for Halon 1301; NAF S III can be used in existing Halon 1301 without major changes to the system; and the costs for replacement of Halon 1301 with NAF S III are minimal. The small quantity of NAF S III used, together with low equipment costs, compared to other alternatives, result in a cost effective installation.

From an environmental standpoint, a key factor in evaluating the viability of Halon 1301 alternatives is the global warming potential (GWP). The Kyoto Protocol to the United Nations Framework Convention on Climate Change binds signatory countries to reduce greenhouse effect gas emissions, including HFCs and PFCs. NAF S III has a GWP of 1444, which is the lowest of any HFC or PFC for normal use. In addition, the atmospheric lifetime (ALT) of NAF S III is 12 years, and the ozone depletion potential (ODP) is only 0.036.

Special conditions or assistance received

A subsidiary in India has been incorporated in the name of North American Fire Guardian, India PVT Ltd. The objective is to supply NAF products to the growing Indian market. Trained personnel have assisted and trained local fire protection system companies in risk analysis, design and installation of NAF systems. All personnel have been trained to design fire-fighting systems using the NAF S III Computer Design Program.

3. CHROME RECOVERY AND REUSE

Company Name	S.V.V. Engineering Industries
City / Country	Hosur, India
Industry sector / Description of products	Small scale engineering Equipment for chrome recovery and reuse in tanneries and pollution control; fabrication of heavy and small equipment in ferrous and non-ferrous materials; and general and precision engineering items
Description of technology acquired and/or changes in production processes	The basic design for chrome recovery and reuse systems was obtained from UNIDO. S.V.V. improved the engineering design and made further modifications to suit local conditions and improve the efficiency of the system.
Support organizations or companies	S.V.V. Enterprises, Hosur, India K.S.V.V. Automobiles, Krishnagiri, India
Special conditions or assistance received	Basic design and technical guidance was received from UNIDO.
Other lessons learned	The system can be maintained by semi-skilled local staff; and the operation and maintenance of the plant is easy and low cost.

Contact Information	S. V. V. Engineering Industries 133 A Sipcot Complex Hosur 635 126 Tamilnadu, India ☎ +91 4344 76747 or 76247 ✆ +91 4344 76747 Mr. S. V. Rajamanickam Managing Partner

Description of process

Tanning Industry in India. The tanning industry in India is the backbone of the leather industrial sector, which consists of tanneries and factories producing footwear, garments, bags and gloves, and other assorted leather goods. This industrial sector provides employment to over 1.7 million people in India and earns about $1.7 billion annually in foreign exchange.

The downstream industries using leather are highly employment-intensive and the bulk of employment provided by these industries is for women. This industrial sector is continuing to expand in India to meet growing domestic and external demand for its products.

Technology in Brief. The chrome recovery and reuse technology includes collection of chrome effluent, screening, precipitation of chrome in a reactor by magnesium oxide (MgO), decantation of supernatant, recovery of precipitated chrome, its dissolution in sulphuric acid and reuse in chrome tanning. The supernatant is reusable in soaking and/or pickling operations in tanning.

Use of Chromium in Tanneries. Basic chromium sulphate is used in converting hides and skins into leather. Over 80% of the leather produced in the world uses chromium in the tanning process.

Description of technology acquired and/or changes in production processes

In the traditional tanning process used generally by the tanning industry in India (and many other developing countries), a significant quantity of chromium (30% to 40% of the quantity applied in the process) is discharged as waste in the effluent. Though chromium settles in the sludge, chrome-bearing sludge is classified as hazardous in many countries if the presence of chromium exceeds prescribed limits. Disposal of such hazardous wastes entails an elaborate and costly procedure.

Environment authorities in the state of Tamilnadu, India, have set standards for discharge of total chromium as 2 mg. per liter. If no chrome management system is used, the discharge of chromium in tannery effluent would vary - between 80 and 200 mg. per liter. The presence of high concentrations of chromium in the sludge would complicate the disposal or utilization of the sludge. Accordingly, an urgent need was felt for drastically reducing chromium in the effluent, so that its presence in the effluent and sludge would be within prescribed limits.

Application of the Technology in India. Technology for chrome recovery and reuse was first applied in India under the Indo-Dutch Project as part of the Ganga Action Plan in Kanpur, Uttar Pradesh, India. However, it did not attract many tanners due to its complexity of design and lack of motivation on the part of the tanners.

Under the project, "Assistance in the treatment of tannery effluent in the state of Tamilnadu" (US/IND/90/244), the chrome recovery and reuse system was thoroughly redesigned and reengineered. A common chrome recovery and reuse system with a reactor capacity of 9,000 litres to serve a group of five small-scale tanneries was set up at Pallavaram, near Chennai (Madras) in Tamilnadu, India, in 1994. This plant has been fabricated and erected by S.V.V. Engineering Industries, Hosur, and has been operated by the tanneries quite satisfactorily from the beginning.

The cost of all mechanical equipment, including field erection, was $52,000, and the payback period for a plant of this size is 2.5 years. The recovered chrome is used by the tanneries regularly. In addition, the supernatant is used in soaking as well as pickling of leather without any adverse effect on the quality of the leather products.

Dissemination of the Chrome Recovery System. Based on the performance of the demonstration plant which was visited by many tanners from Tamilnadu and other parts of India as well as from Sri Lanka, Nepal, Indonesia and other countries, particularly through the UNIDO Regional Programme for pollution control in the tanning industry

Why was this technology chosen and what were the deciding factors

in South East Asia, the chrome recovery technology has found wide acceptance, not only in India but also in other countries of the region.

Development of S.V.V. Engineering Industries, Hosur, India. Subsequent to the success of the pilot chrome recovery system, the technology was widely adopted in India, based on visits by tanners to the demonstration project supported by UNIDO. SVV Engineering Industries was approached by many tanners, indicating a large potential demand for the chrome recovery system in India, particularly in Tamilnadu, where environmental concerns relating to tanneries were becoming manifest and the pollution control authorities were exerting greater pressure on the tanneries to conform to environmental norms. SVV accordingly refocused its business strategy and specialized in the manufacture, supply, erection and commissioning of such systems in India.

Improvements achieved (economic, environmental or others)

SVV has supplied more than 34 plants in India in the past three years. SVV Engineering Industries has also been awarded contracts by UNIDO for the supply, erection and commissioning of chrome recovery and reuse plants in Nepal (1997) and Sri Lanka (one in December 1997 and another one in March 1998).

In both these countries, SVV has supplied such systems to the entire satisfaction of the industry. SVV has acquired the necessary capability to manufacture and supply such systems in a reliable manner. The growth in terms of employees and turnover since 1994 is multifold.

The focus of SVV has been customer satisfaction through on-time delivery, rigorous quality engineering and after-sales services. SVV has acquired the machinery for in-house manufacture of huge fibre-reinforced plastic reactors of up to 50 cubic metre capacity. Currently, the company is venturing into new areas such as computer-aided design and professional execution of chrome recovery plants all over the world.

Growth of S.V.V. Engineering Industries. With the specialization acquired by the company in chrome recovery and reuse system, SVV has been able to supply other specific equipment for tannery effluent treatment plants. Through international tendering procedures, UNIDO has awarded to the company purchase orders for the supply of equipment for tannery effluent treatment in Nepal and India. With its specialization in the manufacture of reactors, other environmental engineering companies are now buying specialized heavy, medium and small, custom-made equipment for water and chemical storage and other fibre-reinforced modules.

Special conditions or assistance received

S.V.V. Engineering Industries started as a small scale engineering industrial unit in 1981, promoted by Mr. S. V. Rajamanickam. For many years, the company responded to small engineering opportunities in Hosur, an industrial town of Tamilnadu. The first major breakthrough for the company came in a contract based on international tendering under a UNIDO project (US/IND/90/244) for setting up a chrome recovery and reuse system in a small scale tannery at Pallavaram, India, in 1994.

S.V.V. Engineering Industries began expanding its manufacturing activities and specialization in chrome recovery and reuse systems as well as other tannery effluent treatment equipment after it came in contact with UNIDO. Within a period of four years, the company had registered impressive growth. SVV has benefitted not only from the technology provided by UNIDO, but also from the interaction with a number of experts fielded by UNIDO under its India Project and Regional Programme.

After completion of this project, the turnover of SVV had increased by ten-fold, from $100,000 in 1994 to $1,000,000 in 1997. Employment has grown from 8 in 1994 to 65 in 1997. The growth of this small scale enterprise with the help of UNIDO is remarkable in the engineering industry, and the company is poised for further expansion and growth.

4. SOLID WASTE TREATMENT

Company Name	A. KISAN Corporation B. DAEWOO Corporation
City / Country	Seoul, Republic of Korea
Industry sector / *Description of products*	A. Environment, construction B. Environment, waste treatment, automotive, construction, hotel, ship-building, engines and others A. THERMOSELECT plants B. THERMOSELECT plants, cars, ships, buildings and others High-temperature recycling plants for waste of any kind with a patented process called THERMOSELECT
Support organizations or companies	ThermoSelect, Italy
Other lessons learned	Environmental protection is currently a political as well as a public concern in the Republic of Korea. Potentially an OECD member, the country is in a period of transition and must implement environmentally sound policies and technologies in the near term. The introduction of high-temperature recycling plants is an important innovation and an advancement in the country's approach to waste treatment and energy recovery.

Contact Information	**ITALY** THERMOSELECT S.r.l. Attn: Mr. Roland Schubert Via Dell'Industria 1-28040 Fondotoce (NO), Italy ☎ +39 323 586 999 ✆ +39 323 586 988 **REPUBLIC OF KOREA** KISAN Corporation Attn: Mr. Hyup Hee Lee Environmental Business Office 406-28 Mok-1-Dong, Yanchun-ku, Seoul, Korea ☎ +82 2 650 6830 ✆ +82 2 653 1015

Additional contact information	**JAPAN** KAWASAKI STEEL Corporation Attn: Mr. Kanazawa Environmental Engineering Department Hibiya Kokusai Bldg. 2-3, Uchisaiwai-cho, 2-chome Chiuoda-ku, Tokyo 100, Japan ☎ +81 3 3597 3111 ✆ +81 3 3597 4453 **SWITZERLAND** THERMOSELECT S.A. Attn.: Ms. Anita Riegel Via Segnale 11, CH-6612 Ascona Switzerland ☎ +41 91 780 5160 ✆ +41 91 780 5161 **UNITED STATES** THERMOSELECT Inc. Attn: Mr. David Runyon / 201 West Big Beaver Road, Suite 230 Ms. Gayle Kennedy Troy, Michigan 48084, USA ☎ +1 248 689 3060 ✆ +1 248 689 2878

VISION 21.

Environmental protection has become a priority nationwide. In a country where 45 million people share a land mass the size of Switzerland (which has 8 million citizens), concern for the environment becomes of paramount importance.

Description of process

In 1996, the Government announced a project called "Vision 21", budgeted to spend 7.7 billion Won ($5 billion) on environmental protection projects over the next ten years. Simultaneously, new and stricter environmental regulations for industries, transport and households are established. A large portion of the budgeted funds will be used for better water quality and treatment of waste.

As an example, the city of Seoul has offered its districts subsidies of 100 billion Won each, if they construct a thermal process for the treatment of their waste by the year 2001. Currently, the city of Seoul produces 9,000 tons of waste daily and thermally processes only 0.7%. In the year 2001, with the incentives, the city expects the thermal treatment of waste to be greater than 30%.

Waste Treatment Problems.

The problems of waste treatment can be focused on two aspects:

- Air emission levels - especially those of dioxin and furan; and
- Landfills - space availability and the impact of runoff on the drinking water supply.

Existing conventional incineration plants in the Republic of Korea do not achieve complete combustion due to the high moisture content in typical waste composition. Dioxin and furan emission levels were so high they were a threat to public health. Most of the existing incinerators were required to undergo retrofitting or to shut down.

Landfills presents a different set of problems. There is no space to build new landfills especially in or close to big cities. And the existing landfills are presenting pollution problems and endangering drinking water quality. A solution to both of these problems had to be found.

Develop, Buy or License Proper Technology?

There were two potential solutions to the waste problems: to develop technology nationally, or to buy or license existing technology to manage the waste properly and respect public environmental concerns. Time, money and risk were all constraints that were taken into consideration when cities, districts and ministries decided to undertake an extensive review of the environmentally sound solutions to waste management that had been successful in other countries.

Attracted by "Vision 21", in 1996, an expert delegation from Songpa, the most future-oriented and visionary of Seoul's districts, began its education by visiting and analyzing modern thermal waste treatment systems in Japan, the United States and Europe. Their mission was to find a technology that would not only treat waste properly, but would also be acceptable to neighboring residents.

On returning to Seoul, they decided that the solution was THERMOSELECT. Information disseminated by newspapers, radio and television made the districts of Seoul and other cities as well as officials from ministries and parliament aware of this technique. A number of visits to the THERMOSELECT plant in Italy followed, and soon the first private companies showed interest in licensing this technology.

Description of technology acquired and/or changes in production processes

KISAN and DAEWOO chose the THERMOSELECT technology in order to establish an environmentally sound process for the treatment of waste. The innovative THERMOSELECT technology provides many ecological advantages as compared to traditional waste treatment systems, which are no longer able to solve the country's waste problem and are no longer accepted by the public.

The deciding factors were: avoiding health-threatening emissions, such as dioxins and furans; avoiding landfills and contamination of drinking water; rapid implementation; better acceptance by the public than conventional waste treatment plants.

The Solution: Thermoselect.

The THERMOSELECT technology converts many different types of waste, including household refuse, commercial and hazardous wastes, scrap and sewage sludges, into usable materials and energy. The

environment surrounding the facility is clean and unharmed by the process. THERMOSELECT provides complete thermal recycling.

Chlorinated hydrocarbons are destroyed safely and reliably, and shock cooling of the high temperature gases eliminates the risk of de-novo synthesis of dioxin. The process produces a practically pollutant-free gas which is five times less in volume than the amount of flue gas produced by refuse incineration. No harmful emissions damage the environment. Measured air emission levels are far below any existing regulated values.

The mineral components of the waste are transformed into inert and non-toxic primary materials. The homogenized molten mineral material is like natural stone and can replace sand and gravel-like granulates as a raw material for concrete or cement. It can also be utilized in making filling materials, elements and pre-forms. Metals are separated out and can be re-used in the metal industry.

The THERMOSELECT process is the only thermal treatment of waste which captures usable water, which is used in the process for cooling. By comparison, in conventional incineration, the water contained in waste is converted into steam and vented into the air together with combustion gases.

THERMOSELECT is the only process which allows complete recovery of the raw materials contained in the input waste. In conventional incineration processing, approximately 40% of the original waste remains in the form of slag, ash, or highly toxic filtrates. The consequential damage and the costs of eliminating the residues are substantial. In the future, new environmental regulations will force incinerator owners and operators to undertake retrofitting and equipment upgrades to vitrify these residues. This will not only be a cost-intensive investment, but also very energy-consuming in operation.

A THERMOSELECT facility is built using a modular concept that provides a great deal of site- and waste-specific flexibility. Because of its standardized components, a facility could be available in 12-18 months. By implementing the THERMOSELECT technology, the waste problems of the Republic of Korea can be solved:

- Practically emission-free;
- With complete material recovery; and
- With wide acceptance by the public.

Stricter standards for emission levels are already implemented. Defined quality standards for products resulting from the process are under discussion within the Ministry of Environment. After the implementation of the first THERMOSELECT plants in the country, the positive impact on the environment will be realized.

Why was this technology chosen and what were the deciding factors

The Thermoselect Waste Treatment Process.

The THERMOSELECT closed-loop process accepts and efficiently processes commingled waste streams which can include municipal waste, commercial waste, appliances and other white goods. The refuse is compacted to about 10% of its original volume, removing much of the air from the waste.

Using a powerful press, the waste is formed into tightly packed plugs which then go into a degasification channel where they form a hermetic seal. In this channel, the waste plugs are thermally heated from the exterior. The organic portion of the waste is converted into carbon which is then treated in the next step, the high temperature chamber.

The inorganic portions of the waste plugs, containing scrap metals and glass products, become molten in the lower section of the high temperature chamber, which reaches a temperature in excess of 2000 C. By gasifying the carbon, a synthesis-gas is produced which serves as an energy source to operate the plant. The balance of the clean, dry synthesis gas is sold in the most efficient, income-producing form, such as gas, electricity, steam, hydrogen or methanol.

The molten inorganic material allows for the recovery of clean metal alloy pellets free of contamination and ready for re-use. The major part of the inorganic material forms a glasslike mineral product that is non-toxic and inert, usable as a cement additive to replace natural stones, or to serve as road-bed aggregate or decorative bricks.

As the hot synthesis gas exits the upper section of the high temperature chamber, it is shock-quenched to a temperature below 90 C. The rapid cooling of the gas ensures that dioxins and furans do not re-form. All the remaining pollutants (acid components and heavy metals) become part of the water stream and are recovered in various forms within the plant. The water contained in the refuse is recycled.

The Republic of Korea Partners.

In 1996, KISAN CORPORATION, Seoul, and THERMOSELECT, concluded a General Agreement for the transfer of know-how of the THERMOSELECT technology and for the license to manufacture and sell THERMOSELECT plants in the Republic of Korea. Since 1997, DAEWOO CORPORATION, Seoul, has become part of the license agreement.

Improvements achieved (economic, environmental or others)

Both of these corporations have been active in engineering design and construction throughout their corporate history. DAEWOO has been dedicated to environmental protection in the areas of waste water treatment and solid waste facilities for many years. KISAN is now entering the environmental industry. Both companies, in addition to the environmental business, recognize opportunities for synergistic effects related to their production and service capabilities. All areas of design and engineering would be managed in-house, as well as construction (site work, concrete-work erection), electrical, precision works, machine tooling, engines, plant operation and training, etc. Not only the main portion of the manufacturing of a plant could be covered in-house, but most of the products produced by a THERMOSELECT plant could be re-used as raw material for their construction business.

The advantage for THERMOSELECT in selling a license to Kisan and Daewoo is two-fold. First, the plant probably could be produced cheaper in the Republic of Korea than in Europe, and quality control would be close to the customer. Secondly, market penetration would be much better, using established and well-respected local companies.

Know-how Transfer.

The license agreement affords a complete transfer of know-how. To guarantee facility quality, the first two THERMOSELECT facilities for the Republic of Korea were delivered from Europe. During the period of construction of those two plants, personnel from Kisan and Daewoo were present and involved with each phase of engineering, construction and manufacturing, until start-up. Once the plants are operational, the technology transfer is complete and implementation of the license takes place. Kisan and Daewoo will then be free to manufacture locally and make use of all possible synergistic effects.

General Impacts.

The awareness of the need to create a cleaner, safer environment in the Republic of Korea became widespread following the publication of "Vision 21", which explained the theory of a safe environment, based on measurement systems, instruments and technologies. Having had no previous regulations on emissions of dioxins and furans, the Korean Environmental Ministry implemented a standard for emission levels of dioxin and furan at a maximum of 0.1 ng/Nm^3. This standard is stricter than in the United States or Japan and follows the most stringent European regulation.

Special conditions or assistance received

The Ministry is now working on defining quality standards for products created by the thermal treatment of waste. The vitrification of slag, ash and filter dust is currently under review. This regulation, when complete, would avoid landfills and the danger of contaminated drinking water that is currently a large concern.

Full technological assistance by THERMOSELECT S.A., Locarno, and THERMOSELECT Engineering S.r.i., Italy, was provided, complete with know-how transfer.

Outlook. "Vision 21" brought to the forefront the need for environmental regulation in creating a safer environment for the Republic of Korea. By implementing the program, the country wants to remedy its lack of environmental standards and to establish and maintain high environmental standards for future generations. Licensing the THERMOSELECT technology brought this goal one step closer. The current economic situation may delay implementation, but the process of obtaining a safer, healthy environment will go forward.

5. WIND ENERGY

Company Name	VESTAS WIND SYSTEMS A/S
City / Country	Lem, Denmark (subsidiaries in developing countries including India)
Industry sector / Description of products	Wind energy Vestas Wind Systems A/S is the world leader in the manufacture of medium and large wind turbines. Vestas' wind turbine range extends from 225kw to 1.65MW and all are pitch-regulated. Vestas uses a partial variable speed system on their 600kw and 1.65MW model.
Support organizations or companies	Comision Federal de Electricidad (CFE), Entec S/A, and New World Power
Other lessons learned	The wind farm at La Venta has helped to stimulate Mexico's wind energy market and thus reduce dependency on oil-fired electricity generation. Around 50% of the CFE's installed capacity currently comes from oil-fired power stations, many of which are inefficient and polluting. A third of the stations are over 20 years old and 43% are between 10 and 20 years old. The increasing use of wind power will not only produce environmental benefits but it will also help diversify energy supply and ensure that the increasing power demands can be met using indogenous resources.

Contact Information	**UNITED STATES** Vestas-American Wind Technology Inc. 19020 N. India Avenue, Suite 4-C Attn: Mr. Hans Jorn Rieks P. O. Box 278, N. Palm Springs CA 92258-0278, USA ☎ +1 760 329-5400 ✆ +1 760 329 5558 **UNITED KINGDOM** European Wind Energy Association 26 Spring Street Attn: Mr. Christophe Bourillon London W2 1JA, U.K. ☎ +44 171 402 7122 ✆ +44 171 402 7125 ewea@compuserve.com

Description of process

Renewable energy technologies often offer the best option for meeting local energy requirements, as well as environmental and economic needs. The export market opportunities for European technology suppliers outside the EU are, therefore, considerable and far from being fully realized. This is in part due to a lack of awareness among decision-makers of the availability and benefits of renewable energy technologies, and in part, due to a lack of awareness among EU technology suppliers of the market potential.

Special Capabilities of the Supplier.

Vestas Wind Systems A/S is a world leader in the manufacture of medium and large wind turbine machines. Since 1979, it has delivered an installed capacity of 1,500MW in 31 countries and, in 1996, had a skills base of 1,600 personnel and a turnover of $287 million. Vestas-American Wind Technology Inc. is a subsidiary of Vestas in Denmark, developing Vestas' business in Canada, the United States and Mexico.

Vestas has a reputation for quality and commitment to research and development efforts, a culture which it has developed and incorporated into its subsidiaries. The company is a market leader for wind energy development, opening country markets by investing in research and demonstration projects and joint venture partnerships.

Wind Farm at La Venta, Mexico.

Description of technology acquired and/or changes in production processes

Electricity demand in Mexico is expected to grow at a rate of 4.7% per year over the next decade, driven by economic recovery and increased living standards. In order to meet this demand, Mexico's ten-year electricity plan anticipates that 15GW of new generating capacity will be needed, of which 6.5GW is expected to be built by the state utility, Comision Federal de Electricidad (CFE), and 8.5GW provided by the private sector.

Renewable energy already provides around 26% of Mexico's total electricity supply, mostly from large-scale hydro. This share is expected to increase to 39% by 2015, with geothermal sources, wind and solar power playing an increasing role. Total wind energy potential has been estimated at over 5,000MW with high wind regimes concentrated on the isthmus of Tehuantepec and the coasts of the Baja California peninsula.

Why was this technology chosen and what were the deciding factors

Background.

Mexico has created many opportunities for renewable energy development by opening up the electricity sector to private companies. In addition to large scale grid-connected wind energy systems, the country is exploring the expansion and application of stand-alone systems.

The La Venta wind farm was set up under a turnkey contract for the state utility, CFE. Entec S/A successfully bid for the project and received financial backing from New World Power, a United States venture capital firm and developer. Vestas supplied seven 225kW wind turbines (excluding towers), control monitoring and control systems, with a two-year warranty agreement, to Entec.

The wind farm, which has been in operation since 1994, has performed much better than expected. Even though the turbines were not optimized for the strong wind conditions, the 1.575MW facility generated more

than seven million kwh in the first year of operation and had a capacity factor of 51%, well above the 30% level generally considered good within the industry.

Thanks to the success of the La Venta project, Entec is planning two larger scale wind projects (20MW and 27MW), and the CFE is also considering setting up its own wind power generation capacity. Long term results will be a diversification of energy supply and increased use of indigenous sources.

Financial Issues.

The investment cost of the La Venta wind farm provided by Entec was around $1,000/kW. Finance was provided by Entec and New World Power under an agreement that costs would be recovered through an annual fee paid by CFE once the project was complete. This type of build-lease-and-transfer (BLT) arrangement was set up by CFE in order to encourage private sector investment in the power sector. This kind of private sector involvement is essential if Mexico is to reach its ambitious generation targets over the next ten years.

Improvements achieved (economic, environmental or others)

Market Opportunities.

Despite its substantial fossil fuel resources, Mexico has created many opportunities for renewable energy development by opening up the electricity sector to private companies and CFE direct involvement in renewable energy projects. As a result, Mexico is the first country in the region to have installed large-scale, grid-connected wind energy systems. The current market trend is for increasing involvement of CFE in wind energy projects, through ownership and operation of small wind farms in the 3-6MW range.

In addition to the centralized power generation market, hybrid wind-diesel energy systems are expected to play a significant role in rural electrification developments. As many as 100,000 villages still have no access to electric power, and of these, only 25,000 are expected to be connected to the national grid in the next twenty years. To help close this gap, the Mexican government is supporting an Alternative Energy Rural Electrification Programme, through its Programa Nacional de Solidaridad (PRONASOL), and is encouraging the use of stand-alone renewable energy technologies. In the agricultural sector, there will also be a role for the private sector as a result of reduced energy subsidies and liberalized policies, which will increase the competitiveness of, and demand for, alternative technologies respectively.

6. BIOMASS COGENERATION

Company Name	REDCO, Inc.
City / Country	Ologbo, Nigeria
Industry sector / Description of products	Wood processing plant Wood sub-products such as chip board, plywood, plyboard
Support organizations or companies	Bono Energia S.p.a. - Feschiera, Borromeo, Italy
Other lessons learned	This is an important step toward improved utilization of natural resources in African countries. Alternative uses of waste materials not only have environmental benefits but also proven financial advantages.

Contact Information	Bono Energia S.p.A. Via Resistenza, 12 — Attn: Mr. Francesco Abba 20068 Peschiera Borromeo Milano, Italy ☎ +39 2 5530 2848 ✆ +39 2 547 1955 — bono.en@bono.inet.it

The Problem

Agricultural and wood harvesting activities generate huge volumes of scrap. Their disposal, due to their high specific volume and organic properties, can cause severe problems to the processors and to the environment that surrounds the processing areas.

Description of process

This biomass is - when properly dried - combustible. It has been a common practice to burn it in open air, or - more recently - to bury it in landfill. Both methods are, in many countries, no longer accepted: the first contributes to air pollution and generates CO_2 (worsening the greenhouse effect), while the second is expensive and dangerous for underground fresh water tables. Many processors, who can supply large quantities of this biomass on a constant basis, therefore, are looking for a proper solution.

The Solution

This vegetative scrap can be burned to yield thermal energy, which can be used to produce steam, heat for industrial processes, or to drive a turbine and generate electricity. The source of energy is extremely cheap and renewable. It can save fossil fuel (normally used to generate steam or heat for factories), and high-efficiency incineration dramatically reduces the volume of scrap to be disposed of and reduces the harmful emissions linked to uncontrolled open-air burning.

However, biomass from different sources is very different in nature, specific volume, conversion yield, seasonality, location, availability of harvesting and transport system, and by-products. They may need specific physical transformation or specific conditioning (fractionating, drying, baling, etc.) before transport to the processing site. A careful study is required for each type of biomass conversion equipment.

Other factors must also be taken into consideration when designing a cogeneration plant. The socio-economic context, which determines the appropriate level of sophistication of the technology; the labor cost, which determines manual or automatic operations; the plant's efficiency level, that influences the balance between cost of operation and revenues; the capacity level; the energy requirements of the areas surrounding the processing plant; local legislation, and the competitive or monopoly situation of power production plants.

Bono Energia has studied this problem and provides a number of different turnkey plants to process diverse types of biomass, and has experience in various countries and under different socio-economical contexts. The most recent examples of plants supplied include processing of derivatives of wood, rice, grapes, olives, palmoil and sunflowers. Other potential raw materials are natural oil-rich husks (nuts, nougats, various shells), seeds, dried portions of green vegetables (sugarcane bagasse) and dried animal waste.

Description of technology acquired and/or changes in production processes

The Transfer of Technology

REDCO Inc. of Ologbo, Nigeria, are wood processors producing chipboard, plywood and plyboard. Their process generates a high volume of wood scrap (bark, branches, scrap wood, etc.) and requires heat for the presses producing chipboard. Cogeneration was studied taking into consideration the fluctuation in the flow of wood through the plant during the year, the specific characteristics of the biomass, the requirements of steam for the process, and the requirement to use electricity for the plant and sell the excess to the local power company.

Why was this technology chosen and what were the deciding factors

The contract was made directly between Bono Energia and REDCO, through a conventional bid and offer. The package supplied included:

- Design of a customized plant, according to the customer's specifications for raw materials and needs;
- Construction of the combustion system, high-pressure water tube boiler and ash discharge system;
- Supply of drawings for local construction of feeding and pre-processing equipment;
- Delivery, installation and testing of the turn-key plant; and
- Technical training of local operators, on site.

Improvements achieved (economic, environmental or others)

The results were: the problem of disposal of several tons per day of wood scrap has been eliminated; VOC/CO emissions have been reduced; and significant economies have been achieved, resulting in savings every year, such as:

→ several tons of fossil oil previously burned to heat the presses used for the production of chipboard;

→ electric power previously purchased to operate the plant's equipment, lights and electric devices; and

→ revenues generated by selling excess electricity to the local power company.

Two important lessons were learned with this project:

- Energy recovery from biomass by means of a cogeneration plant is not a solution that processors are likely to initiate on their own; it must be proposed and tailored to their needs;

- Cogeneration is economic for small and medium-users, due to the combination of savings and income; its return on investment period is very short (2-4 years, according to local conditions).

7. SUBSTITUTES FOR CFCs AND VOCs

Company Name	Simmons Argentina, Limansky, Piero, Suavestar, Sueno Estelar
City / Country	Buenos Aires and several other Argentinian towns
Industry sector / Description of products	Production of polyurethane foam Flexible foams for the furniture industry, mattresses, sport clothing and sound insulation applications
Support organizations or companies	Cannon Group, Milano, Italy, and the United Nations Development Programme (UNDP)
Other lessons learned	An environmentally sound technology for the production of polyurethane yields equal quality at a lower cost.

Contact Information	Cannon S.p.A. Via Colombo, 49 Attn: Ing. Bruno Fierro 20090 Trezzano s/n Milano, Italy ☎ +39 2 4840 0765 ✆ +39 2 4456 6508 ✇ welcome@cannon.it

Description of process

The Problem

Polyurethane foams are synthetic expanded polymers used in a wide range of consumer goods because of their physical and mechanical properties - mainly comfort, sound absorption and thermal insulation. The best known applications are - in the form of flexible foams - in the furniture industry (mattresses, cushions, padding), for automotive purposes (seats, sound-deadening elements, safety items), in sport and leisure articles (clothing for cold weather and for shock-proof garments).

To be produced as foams, polyurethanes need to be expanded during the chemical reaction that forms them. The most common expanding agent was CFC11 (a volatile chlorofluorocarbon), banned as ozone-depleting by the Montreal Protocol. A valid expansion alternative had to be found. More than 7 million tons of polyurethanes are produced every year, contributing to the comfort of our lives and saving thousands of tons of fossil combustibles, thanks to their thermal insulation properties.

The Solution

The Cannon Group has invested heavily in research and development and has developed a blowing technology based on natural liquid carbon dioxide (NLCD) for continuous foaming applications to make flexible foams. This technology replaces CFCs with a low-cost, environmentally-friendly, non-ozone-depleting, alternative blowing agent widely available in nature and widely used by the food and processing industry.

This blowing agent is derived from other industrial manufacturing processes. Therefore, its use does not add further CO_2 to the atmosphere and is not a problem to global warming. Its blowing efficiency is 3 - 3.5 times higher than that of the previous expanding agent, and its cost is 5 to 8 times less than CFC11. It also allows for the production of more comfortable, lighter foams.

Description of technology acquired and/or changes in production processes

Launched in November 1993 at the World Polyurethane Congress in Vancouver, Canada, this process - patented under the trade name of CarDio™ - has immediately found several industrial applications in Europe (Italy, Germany and Poland) and the United States. After the first industrial experiences in developed countries, Cannon contacted the Montreal Protocol Multilateral Fund Agencies in order to promote this solution for the replacement of CFCs and VOCs (Volatile Organic Compounds) in developing countries as well.

Why was this technology chosen and what were the deciding factors

The Transfer of Technology

UNDP had contacted the Argentine government to develop a country program for the phase-out of CFCs. An "umbrella solution" was envisaged for the replacement of CFC11 used in polyurethane foams for the production of mattresses and furniture seats.

Five major Argentine producers had the size and production volume to justify an intervention under the government's coordination. The manufacturers - Simmons Argentina, Limansky, Piero, Suavestar, Sueño Estelar - submitted their industrial plans for the conversion of existing foam machines and the acquisition of new ones. They initially proposed the conversion from CFC11 to methylene chloride, an alternative blowing agent included as a technically-accepted solution in the Montreal Multilateral Fund (MMF), but this VOC was not accepted by the Argentine authorities because of its possible effects on workers' health and on the air around the plants. This farsighted decision forced a search for another blowing alternative.

Cannon was contacted - among other potential suppliers - to provide an alternative solution based on NLCD. The five producers' plans were discussed as a single project, thus allowing for a substantial saving in costs for purchase of parts, transport, logistics and manpower. After a detailed discussion with the foam makers, a group-visit to the Polyurethane (PU) Exhibition in the Netherlands as well as to several competitors and to one of the converted CarDio™ industrial plants in operation, the Cannon solution was accepted.

The projects were then approved for financing by the Commission in charge of this geographic and technological segment of market. UNDP submitted to the Executive Committee of the Montreal Multilateral Fund (MMF) the change of technology from methylene chloride to NLCD, and this solution - although slightly more expensive for the Fund - was accepted.

The conversion of the existing foaming plants was carried out in seven months between 1997 and 1998, and a thorough on-site training of the production personnel completed the technical phase. Today all the plants are in operation with NLCD, and the vast majority of foam grades are produced without CFCs.

Improvements achieved (economic, environmental or others)

The Results - The following results were achieved:

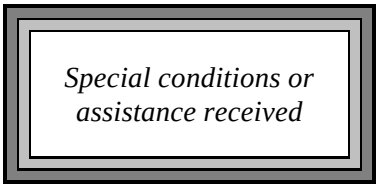
- Elimination of CFCs and VOCs from a major industrial end-use;
- Replacement with a cheaper and safer chemical component;

- Reduction of foam weight due to lower achievable densities; and
- Production of high-quality, more comfortable foams.

Two very important lessons were learned with this project:

- Environmental protection and economics can go together. It is not always true that there is an extra cost to pay for adopting environmentally safe manufacturing methods.

- Cooperation among a group of users under the coordination of a government or public authority offers major advantages: trips, preliminary contacts and offers can be optimized. Also, if the projects are technically similar and delivery times are roughly in the same period, money can be saved in designing, engineering and installing the new technology.



The project was based on:

Turn-key conversion projects of existing foaming plants; and

On-site personnel training.

Further information on Natural Liquid Carbon Dioxide-blowing technology for continuous or molded polyurethane, handled directly or within the framework of Multilateral Funds-sponsored projects, can be requested from the contact points above.

8. CLEANER STEEL PRODUCTION

Company Name	Acerlan, S.A. de C.V.
City / Country	San Juan del Rio, Queretaro, Mexico
Industry sector / Description of products	Foundry Steel valves and railroad ties
Support organizations or companies	Lanzagorta Industries, and the United Nations Industrial Development Organization (UNIDO)
Other lessons learned	This big company knows and understands its foundry process. It recognized a cost-effective, sound business mechanism to add environmental protection to its operation.

Contact Information	Camino a San Pedro Ahuacatlan 3 Zona Industrial 76800 San Juan del Rio, Qto. Mexico ☎ 52 427 21025 ✆ 52 427 28481 Mexican Cleaner Production Centre Av. IPN s/n, Lab. Pesados de Fisico Matematicas, 1er Piso Unidad Profesional de Zacatenco 07738 Mexico, D.F. Mexico ☎ 52 5 729 6201 ✆ 52 5 729 6202 ✇ mnajera@vmredipn.ipn.mx

Attn: Ing. Alejandro Hugues
General Manager

Description of process

Acerlan S.A. de C.V. is a large Mexican foundry enterprise whose principal activity is in the steel sector. The plant has a payroll of 630 employees. In relation to its foundry process, the system consists of two 7-ton electric arc ovens as well as two induction ovens with capacities of 500 and 1000 Kg. Ninety per cent of its production is destined for the fabrication of valves for water and other liquids and the other 10% for the railway industry. The volume of production is approximately 10,000 to 12,000 tons of steel per year.

As a company under pressure from the local government to apply environmental controls, Acerlan decided to participate in the second demonstration project of the Mexican Cleaner Production Centre. The MCPC

assistance lasts one year with the UNIDO five-phase approach, a local coordinator and two visits for international experts.

Existing pollution problems

The principal pollution problems with known options for improvement were the following:

- Inefficient use of energy;
- Emission of particulates and smoke in the working environment;
- Waste and residue from "refractor";
- Residue of sand burnt with resins.

Description of technology acquired and/or changes in production processes

The improvements did not involve changes in the basic production process, but rather refinements in management, control operations and maintenance, including:

- Improvement in process control;
- Increased maintenance of area and equipment;
- Increased ventilation of working area;
- Improvements in energy management.

The benefits achieved include:

- Reduction in raw materials use and costs;
- Reuse of by-products and rejected material;
- Reduction in occupational risk and long-term occupational costs;
- Savings in energy use, compared to energy costs at present time.

Why was this technology chosen, and what were the deciding factors

An economic assessment of the changes show:

- Approximately $120,000 per month saved by improving the control of steel oxidation and 10% reduction in use of oxygen;
- A 5% reduction in energy consumption through better maintenance of arc furnace lid;
- Approximately $20,000 per year saved by modifying the arc furnace doors with an investment of only $950;
- A 14% fuel savings for installing air/fuel programming controls, equivalent to about $21,000 per year;
- An investment of approximately $6,500 for improving moulding area to reduce risks to workers.

Opportunities for cleaner production

The opportunities for cleaner production processes indicated by the MCPC evaluation were as follows:

Improvements achieved (economic, environmental or others)

Technical Solution	Opportunities	Economic Benefits	Environmental Benefits
Reduce the amount and emission levels of paint used	Change of refracting moulding paint from oil-based to water-based paints as well as move to "flow coat" process to reduce point use	Estimated savings of 16.9% through paint substitution and reduction	Reduction of emissions of solvents in the working environment
Improve the air quality in the area of casting and draining	Improvement of ventilation in the casting and draining areas; Investment for this purpose was $51,717 -- payback period not assessed	Indirect savings	Reduce the emission of smoke and particulates in the working area
Reduce use of resins and catalysers; Improve process controls	Optimization of the quantity of resins and catalysers used in the mix. New mixes of resins and catalysers will be tried, starting from existing practices to estimate the optimal mix, based on economic and environmental considerations	Savings in the reduction of quantities of resins and catalysers used	Reduce the emissions of organic gases in the working environment
Improve air quality inside the plant	Study of construction of closed area for cleaning of draining ladles in order to control emissions from this process and use improved extraction process	Indirect cost benefits	Reduce emission of smoke and particulates in working area
Reduction of area of rust scale storage	Increase the reuse of metallic rust scale and avoid accumulation by using them at the moment of generation, and reduce production of scale	The savings per ton of scale reduced or reused is $1,725 with reduction in the use of energy and gas	Reduction of waste product
Reduce heat loss and emissions from ovens	Improve maintenance of seals of electric arc ovens to avoid flames and smoke leaks	Reduction in the use of electricity by up to 5%	Reduction of emissions of smoke and particulates from working environment
Reduce risk of flames escaping from the oven	Installation of flame controls in oven electrodes	Lower costs of security and lower risks	Reduce atmospheric emissions and noise

Technical Solution	Opportunities	Economic Benefits	Environmental Benefits
Reduce heat losses and emissions	Modification of doors to the arc ovens in order to keep them closed as much as possible. Cost of this modification was $7,572 -- payback period was not established	Annual savings are estimated at $159,000 for both ovens; Considerable energy savings	Reduce the emissions of smoke and particulates in the working area
Improve operation of transformers	Improvement of the cooling systems of the transformer for arc oven "B". Cost of this investment was $139,200 -- payback period estimated at 14 years	Estimated annual savings of $9,954 for both ovens	Indirect benefits
Better use of energy	Change process of pre-heating kettles	Savings in energy use for heating pans	Indirect benefits
Improve efficiency of the process; Improve quality of product	Reduction of waste in steel production; use of metallurgic lime instead of limestone	Savings in energy; Reduce cost of waste disposal	Reduce the amount of smoke and waste
Reduce the use of oxygen and iron mixes	Improvement of steel oxidation process; Optimize time alloted for steel oxidation through trials	Savings in the cost of oxygen and iron mixes	Indirect benefits
Improve extraction systems	Improvements in the design of extraction systems for emissions generated by the arc ovens; Cost of this measure estimated at $10,000 -- payback period not established	Indirect benefits	Reduce levels of emissions

9. FISH PROCESSING

Company Name	Alimentos Marinos S.A.	Pesquera Camanchaca S.A.
	Pesquera Landes S.A.	Pesquera San José S.A.
	Pesquera Qurbosa Ltda.	Pesquera Itata S.A.
	Pesquera El Golfo	Pesquera Loa Sur S.A.
	Pesquera San Pedro S.A.I.C.	Pesquera Pacific Protein S.A.
	Sociedad Pesquera Bío Bío Ltda.	Pesquera San Miguel S.A.
	Pesquera Miramar S.A.	Pesquera Vásquez y Cía Ltda.
	Pesquera Iquique Guanaye	Pesquera Timonel
City / Country	Concepcion, Chile	
Industry sector / Description of products	Fish processing Fish meal and oil	

Contact Information	Ms. Marlene Roeckel Ms. Estrella Aspe Ms. Cristina Marti Departamento de Ingenieria Quimica Facultad de Ingenieria, Casilla 53-C Universidad de Concepcion Chile ✆ +56-41 243 750 mroeckel@merlin.diq.udec.cl

Introduction

Developed countries usually have clear environmental laws that regulate industrial effluents and environmental quality. As Chile will soon legislate on these matters, the local fish processing companies, thorugh the Fisheries Association (ASIPES), asked the Chemical Engineering Department of the University of Concepcion to perform an evaluation of different technical alternatives to comply with those regulations.

Grants from UNIDO and FONDEF-Chile supported the design of a new process that increases the fish processing productivity and reduces environmental pollution. Assays, at bench and pilot scales, suggest that organic matter recovery could amount to 10% of the catch, making the process economically attractive.

Diagnosis

The incidence of effluent generated during various stages of fishmeal production relative to the total effluent to the environment was assessed by studying 17 local fisheries (1988-1992). The effluent generated during the pumping of the catch from the ships' holds to the wharf constituted 87% of the organic matter dumped to the sea, and its volume was more than 90% of the total effluent.

The Market for Transfer

Chile is one of the world's largest producers of fishmeal. In 1996, its fishmeal production reached about 1,400,000 tonnes, of which 42% were processed in the 8th region. Marine product exports are the second largest source of revenues for the 8th region and constitute about 27% of Chilean exports of these products.

The market was studied based on the fishmeal factories operating in 1994. Technology transfer was considered at three levels: local (8th region), national (Chile) and continental (South America). The analysis included the following elements: size (amount of catch processed by each company in 1994, which relates directly to their fishmeal production); technological level (assessed by the availability of indirect and film dryers as replacements for old dryers, such as direct dryers and traditional evaporators); and professional level (assessed by the educational level of the company's personnel).

The results show that: 62% of fishmeal production was carried out at a high technological level, and 72% at a high professional level. Four companies produced half of the total fishmeal production (49.9%). These characteristics indicated that the companies could immediately adopt the new technology.

Technological Proposal

The proposal involved the following technological changes:

Implementation of a pressure-vacuum pump unloading system to reduce water consumption (0.5-2 m^3 per tonne of fish) compared to the centrifugal pumping presently in use (5-10 m^3 per tonne of fish), as well as to reduce the organic load dumped to the sea to 3 kg COD/tonne of catch.

Installation of screens to retain coarse solids from the unloading and further reduce the COD by 5%.

Recycling the unloading water so as to reduce to about 120 m^3 per day the volume to be treated and increase the soluble protein concentration; company-scale assays showed a 67% reduction in COD.

70% protein recovery can be achieved by flocculation followed by cold centrifugation; the recovered matter can be incorporated into production if it is dosed so as not to exceed the limits for chloride concentration (2.7%) in the resultant fishmeal.

Combined anaerobic-aerobic treatment of the remnant effluent; the anaerobic degradation of organic matter (mainly protein) gives rise to ammonia, which must be oxidized to nitrite and nitrate by an aerobic step. Both reactors are presently installed, at a pilot scale, in one of the local plants.

In summary, the proposed technological change could reduce by 90% the organic load dumped to the sea and increase productivity by 1.6 tonnes of fishmeal per 100 tonnes of catch by recovery of this organic load, representing a 7% increase in fishmeal yield. Changing from direct to indirect drying produces a better quality and more valuable product, while changing from traditional to film evaporators allows heat recovery by recycling the excess heat generated by the dryer.

1. UNLOADING PUMPS	
Support organizations or companies	University of Concepcion and IRAS
Description of technology	Pressure vacuum pumps for fish unloading
Why was this technology chosen and what were the deciding factors?	The new technology involves a vacuum-pressure cycling system that pushes the fish from ship to shore and thatis less disruptive than previous pumping systems. With the new technology, solid wastes from unloading are eliminated, in contrast to centrifugal pumps. With this system, the fish are not damaged during unloading, resulting in better quality fish meal and a higher yield.
Special conditions or assistance received	Research project of the Chemical Engineering Department, University of Concepción - Chile, was funded by UNIDO (Project US-CHI 90-284) and the Association of Fishing Industries (ASIPES). Technical staff of the University of Concepción were supported by UNIDO experts, and study tours were made to similar systems all over the world. Full-scale experiments were carried out at selected fish processing plants. The research project's recommendations included a change in the industry's unloading system, as the first step to the achievement of clean technology and increased productivity.
Improvements achieved (economic, environmental, others)	There is a 6.3% increase in the amount of unloaded fish when the PV pump is used, compared to centrifugal pumps. Theoretical savings are 6.4 to 24.6 kg of fish meal /ton of unloaded fish. The investment is repaid after unloading about 19.000 to 70.000 tons of fish. The amount of water used for unloading the fish is reduced: the ratio of water to fish is 5/1 for centrifugal pumps, and 2/1 for PV pumps. By changing centrifugal pumping to pressure vacuum pumps, flow and organic matter content are drastically reduced.

1. UNLOADING PUMPS	
Other lessons learned	Assess all technologies available before proposing a final solution. Identify a technical "focal point". Identify an industrial association to coordinate the process of technology transfer and ensure effective dissemination. Transfer clean technology in steps. The reduction of waste in the fish processing industry is technically feasible.

2. RECOVERY OF SOLID PARTICLES	
Support organizations or companies	University of Concepcion and NAHUELCO/Johnson Screens
Description of technology	Static screens and rotating drums used following unloading of fish
Why was this technology chosen and what were the deciding factors?	The introduction of screens and drums to fish meal processing recovers coarse particles, scales and other fish parts during unloading, and adds them into the fish reduction process, increasing productivity. Another factor in choosing three-planed screens or rotating drums is the recovered matter moisture (78% and 79%, respectively).
Special conditions or assistance received	Research project of the University of Concepción funded by UNIDO (Project US CHI 90-284) and the Association of Fishing Industries (ASIPES). Technical staff of the University of Concepción were supported by selected UNIDO experts. Study tours were made to similar systems around the world. Laboratory-scale experiments identified preferred alternatives and best equipment design for organic matter recovery. Pilot systems were installed at selected fish processing plants for full-scale experiments. Following evaluations, the University of Concepción recommended that the fish processing industry install screening systems both to achieve clean technology and increase productivity.
Improvements achieved (economic, environmental, others)	Organic matter recovery (measured as filtered solids) of 2 and 4 kg per tonne of fish unloaded with pressure vacuum and centrifugal pumping, respectively, was achieved, increasing process and product yield. The organic matter (measured as COD) reduction in effluents to the sea averages between 5% and 41% for pressure-vacuum pumping and centrifugal pumping, respectively (initial COD values 3 and 25 kg/m3, respectively).
Other lessons learned	The transfer of clean technology is best undertaken in steps. The organic load abatement achieved not only recovers organic matter but increases plant productivity and income.

3. DRYING	
Support organizations or companies	University of Concepcion and ESMITAL
Description of technology	Falling film evaporators and indirect dryers.
Why was this technology chosen and what were the deciding factors?	Indirect dryers heated by steam, dry fishmeal more gently. Fish particles do not overheat, thus avoiding the quality reduction previously caused by caramelization. Evaporators use less heat because they transfer heat more efficiently and because they permit heat recycling. Energy costs are reduced.
Special conditions or assistance received	Research projects of the University of Concepción funded by UNIDO (Project US CHI 90-284) and the Association of Fishing Industries (ASIPES). Study tours were made to the fish processing industry all over the world. Analysis of effluents from dryers and evaporating systems were performed at selected fish processing plants chosen as models of "old technology" and "clean technology". Following evaluations, the University of Concepción recommended to the fish processing industry the installation of indirect dryers and falling film evaporators to achieve both clean technology and increased productivity.
Improvements achieved (economic, environmental, others)	For a processing rate of 40 tons of fish/hr, changing from direct to indirect dryers reduced the thermal load a factor of 10. A standard factory could pay for the new equipment in five years, using just its savings in energy costs. When changing from direct to indirect dryers, the organic load dumped into the sea is reduced from 3.2 to 0.4 kg of COD/ton of processed fish; and when changing from the conventional to falling film evaporators, the organic load is reduced from 2.0 to 1.4 kg of COD/ton of processed fish.
Other lessons learned	The fish processing industry needed to improve the quality of fish meal in order to compete on international markets. The change to indirect dryers was quickly adopted because it permits improved drying, without amino acid decomposition in the fish meal, thus improving the quality and therefore the price of the final product.

Tables 1 and 2 show the characteristics of fish processing effluents before and after applying the clean technology concept. Table 2 also shows the economic evaluation of the alternative processes for a typical processing plant.

TABLE 1: REDUCTION IN POLLUTION INDEXES
Organic load dumped to the sea - before and after installing clean technology

PROCESS	PREVIOUS TECHNOLOGY (kg COD/tonne of catch)		CLEAN TECHNOLOGY (kg COD/tonne of catch)	
UNLOADING	centrifugal pump	25.3	vacuum-pressure pump	3.0
DRYING	direct	3.2	indirect	0.4
EVAPORATION	conventional	2.0	falling film	1.4
WASHING	without treatment	1.0	physical/chemical/ biological treatment	0.2
T O T A L		31.5		5.0

TABLE 2: COST OF CHANGE OF TECHNOLOGY

	1st ALTERNATIVE: Keep Centrifugal Pump	2nd ALTERNATIVE Change to PV Pump
Present Net Value at 10%	1,144,000	2,972,000
Return on Investment	-------	53%
Maximum time to recover investment (years)	-------	2
Economic benefit ($/tonne of fishmeal)	-------	3.27

Results of the technological transfer

Local fish processing plants have made the following changes:

Unloading system: the percentage of the catch unloaded by pressure-vacuum pumping rose from 10% to 60% between 1988 and 1995. Over 90% of the local plants presently use this system for catch unloading.

Installation of equipment for solids recovery: the percentage of the catch unloaded with solids recovery increased from 20% to 90% since 1988.

Recycling of the unloading effluent: 50% of the local plants have considered or actually designed recycling systems since 1988.

Indirect drying and falling film evaporators: almost 100% of the local fisheries have switched to this type of equipment.

Conclusions

In order to apply the clean technology concept to fish processing, changes in their unloading system and their production process were needed. These changes have been well accepted by the local companies. The technological changes have proceeded in a steady gradual manner since the economic and social benefits were established. The more technologically advanced industries are better equipped to implement these changes and thus to increase their productivity through these changes.

Internet Cafe

Information Trail for Decision Making

The objective of the Internet Cafe was to demonstrate how to find and apply information to minimize the impact of industrial activity on the environment. It was specifically aimed at governments and industry.

In its previous sessions, the CSD identified the need for good information exchange mechanisms to facilitate technical cooperation and transfer. UNEP's Internet Cafe is one response to this need. It:

illustrates how to address environmental problems in an integrated fashion;

highlights primary information paths that governments and industry managers can use to identify potential solutions to environmental problems; and

demonstrates how to use electronic information sources and link between them.

The Internet Cafe was prepared by the United Nations Environment Programme (UNEP), particularly the Industry and Environment Centre (UNEP IE), in cooperation with the International Environmental Technology Centre (UNEP IETC), the UN Conference on Trade and Development (UNCTAD) and the UN Industrial Development Organisation (UNIDO).

WHY THE INTERNET CAFE?

As the environmental consequences of any industrial activity rarely affect just one medium (air, water, land etc.), it is important to understand the impact of an activity on the environment as a whole.

Currently, much of the information disseminated on industrial applications only partially address environmental issues. For example, information on a new, "cleaner" process technology may focus on the reduction of unwanted by-products but not provide information on related environmental issues such as consumption of raw resource and energy during the production process, emission of greenhouse gases, production of hazardous waste, etc.

Consequently, governments and industry managers are often unaware of the possible, wider environmental impacts of a specific activity. If they are aware of the need to look at broader environmental issues, they often do not know where to obtain the relevant information. A third, related problem is understanding the information and correctly applying it to the situation at hand.

The Internet Cafe provides information on both the specific and broader environmental issues associated with a select number of production processes.

HOW DOES THE INTERNET CAFE WORK?

The Internet Cafe consists of six modules, each dedicated to a particular industry sector:

- pulp and paper manufacturing
- mining
- municipal solid waste management
- metal finishing
- sugar processing
- leather processing

Each module outlines a typical production process and its potential impacts on air, water, land, energy, and worker health and safety.

All information is displayed electronically with links to relevant publications, information systems, technology centres and working groups. Reference is also made to relevant hard-copy publications which are available for reference in the Cafe. Information on technical, operational, managerial, and government responses, including links to case studies and examples, are provided. A list of commonly asked questions with references to additional information sources compliments the module.

UNEP has chosen an interactive format for this display to illustrate an integrated approach to environmental management.

INFORMATION TRAIL FOR DECISION MAKING

Governments and industry need to find, assess, and use information in the proper way. Below are three key questions that should be asked at the start of the "information trail" if sustainable production is to be achieved.

✦ WHAT IS THE SOURCE OF THE ENVIRONMENTAL

Key questions for officials: **Key questions for industry managers:**

✦ HOW TO ANALYZE THE PROBLEM? ✦

✦ WHAT MEASURES WILL HELP AVOID OR REDUCE THESE IMPACTS ✦

Key questions for officials: **Key questions for industry managers:**

what management systems can be applied?

BACKGROUND

UNEP established its **Industry and Environment Centre (UNEP IE)** in 1975 to bring industry and government together to promote environmentally sound industrial development. Its goals are:

to build consensus for preventative environmental protection through cleaner and safer industrial production and consumption;

to help formulate policies and strategies to achieve cleaner and safer production and consumption patterns, and then implement them;

to define and encourage the incorporation of environmental criteria in industrial production; and

to stimulate the exchange of information on environmentally sound technologies and forms of industrial development.

UNEP IE focuses its efforts on the transfer and implementation of clean industrial technologies. It develops partnerships with industry, government and non-governmental organizations. UNEP IE organizes conferences and seminars, undertakes training activities and demonstration projects. UNEP IE also produces practical supporting publication, such as the *Industry and Environment* quarterly review and the technical report series, as well as other handbooks, training materials and information diskettes which provide practical information to decision-makers throughout the world.

UNEP established the **International Environmental Technology Centre (IETC)** to address the issue of technologies for sustainable urban and freshwater basin management. The Centre promotes cooperation in facilitating the transfer of environmentally sound urban and fresh water technologies to developing countries and countries with economies in transition. IETC pays specific attention to urban problems such as sewage, air pollution, solid waste, noise, and to the management of freshwater lake and reservoir basins.

UNEP IETC pursues a results-oriented work plan revolving around three issues as related to urban and fresh water basin management:

improving access to information on ESTs;
fostering technology cooperation, partnerships and transfer; and
building endogenous capacity.

UNEP IETC also publishes a quarterly newsletter; a technical publication series and other media materials creating public awareness and disseminating information on ESTs.

FOR MORE INFORMATION:

UNEP on the Web at http://www.unep.org

UNEP IE on the Web at http://www.unepie.org

UNEP IETC on the Web at http://www.unep.or.jp

PART III: ORGANIZATION OF THE INDUSTRY AND TECHNOLOGY EXHIBITS

A. BACKGROUND

It is generally recognized that the often difficult international negotiations on technology transfer could benefit from progress towards practical solutions. The exhibits at the sixth session of the Commission on Sustainable Development (CSD), based on practical examples of technology transfer by both transnational corporations (TNCs) and small and medium size enterprises (SMEs) from developing countries, provided evidence that:

> Transfers of environmentally sound technologies (ESTs) are feasible and are taking place within the framework of private sector investments;
>
> Greater transfer of ESTs is constrained by certain policies and institutional arrangements, and new policies, approaches and institutional support can facilitate the cost-effective diffusion, application and use of these technologies;
>
> The pace of technology diffusion can be accelerated through a range of practical, low-cost or no-cost initiatives.

The activities included exhibits/networking booths and presentations/discussions that facilitated interaction and information exchange between industry participants and delegates and other participants in CSD-6. The efforts to encourage direct interaction between industry participants and delegates were supplemented by a media relations effort designed to share the knowledge gained from industry experience more broadly through the media.

Based on case studies, the exhibits and presentations identified factors and requirements influencing company investment decisions related to the transfer, application and use of ESTs. This approach provides a basis on which to assess the effectiveness of different forms of governmental and other interventions to accelerate the pace of the global diffusion and use of ESTs.

As the primary owners and users of ESTs, industry views are an essential input for knowledgeable decision-making regarding the role of governments in facilitating the transfer of ESTs. The exhibits and presentations broke new ground in enhancing opportunities for industry to contribute to the discussions in the Commission. The exhibits and presentations profiled the successful experiences of at least thirty companies. The views of both TNCs and SMEs from fourteen countries provided Commission participants with information with which to evaluate policy positions and areas for government action.

The presence of the exhibits and of over sixty industry personnel for the duration of the CSD-6 session also served as a reminder to the delegates of the importance of technology transfer as a core issue in moving towards patterns of sustainable industrial development, of the potential that exists for real progress in technology transfer, and of the expectations of industry in both developed and developing countries that practical actions will be taken by governments and international organizations to accelerate the pace of technology diffusion.

Organizers and Funding Sources

The exhibition was sponsored, funded and organized by:

with additional funding from:

Financial support for participation of enterprises from developing countries was provided by their industrial partners from developed countries as well as by UNIDO and international sectoral industry associations.

B. APPROACH AND STRUCTURE

1. Objectives

The objectives set for the programme were to:

Illustrate the nature of technology transfer processes by profiling examples of successful transfer of ESTs;

Demonstrate that the discussions on technology cooperation are backed by industry commitment and experience; and

Allow industry representatives, as the principle owners and users of technology, to contribute to the consideration of these issues.

In order to promote the exchange of information between industry participants and delegates, the exhibits and presentations were designed to maximize interaction between industry participants and delegates.

2. Considerations and Approach

a. Corporate decision-making and the processes of technology transfer

The international transfer of ESTs takes place within a bewildering array of circumstances and for a wide range of reasons (e.g., a response to a regulatory requirement, as a stand-alone cost-saving measure, or as part of a global program to reduce greenhouse gas emissions). An understanding of the manner in which such factors and requirements influence company investment decisions is essential to assessing the merits of government initiatives.

By examining these decision-making processes, it is possible to identify the political, economic, trade, regulatory and legal policies as well as support infrastructure required to promote international technology cooperation and investment and the motivation of industry to adopt ESTs. For these reasons, the programme was designed to illustrate corporate decision-making processes that lead to technology transfer and identify factors that either contribute to or constrain such investment.

b. The case study approach

A case study approach is an effective way to illustrate corporate decision-making processes. The emphasis in the case studies was on companies' motivations and incentives for the technology transfer. In particular, exhibitors were asked to address the following questions in the organization of their exhibits and presentations.

Why and how did the project arise? Why this project in this country?

How was the overall investment risk associated with the project assessed?

What factors influenced the technology selection process and how were procurement decisions made?

What was the motivation for the EST component of the project?

How was the technology needs assessment conducted? Was the project subject to an environmental impact assessment?

Was a business case made for investing in the EST? How?

How was the technology procured and financed?

What were the implications of the decisions relating to EST transfer or procurement for the user organization (e.g., upgrading human resource skills, management) and how were these requirements met?

What issues constrained the investment decisions and/or the cost-efficiency of project implementation?

Have technological innovations been made since the original investment? Why? By whom and how were these innovations made?

How did the introduction of the EST affect corporate competitiveness?

Making the business case for investing in ESTs is particularly difficult for SMEs, given their need to remain competitive. Social and environmental sustainability cannot be based on uncompetitive firms. Specific motivations for SMEs to adopt ESTs, particularly in developing countries, may be absent (e.g. environmental regulations, standards and enforcement). In these circumstances, the task of creating awareness, motivation and the knowledge to make a compelling financial case for SME investment in ESTs can be daunting.

3. Networking Booths and Tabletop Exhibits

Company booths were designed to maximize the interaction and exchange of information between industry participants and national delegations. Most exhibits were of the desktop variety or set up as networking booths. The exhibits were not focused on the capabilities of specific technologies, but on technology transfer processes and requirements.

4. Booth Design

In keeping with the theme of sustainable development, the booth walls were specially designed for the exhibit area and were made of recycled and recyclable materials, fabricated into panels that fit together like a jigsaw puzzle. Creative Engineering, Inc. of New York was hired to design and build all exhibit

infrastructure and signage. All other services required were provided by the United Nations. Following the exhibition, the panels were retained by the United Nations Exhibits Committee for future use.

5. Selection of Participants

To ensure a variety of cases (North-South, SMEs-TNCs, themes, regions, etc.) and the quality of both exhibits and presentations, participation in the program was by invitation. Suitable exhibitors and presenters were identified with the assistance of supporting organizations, national environment ministries, sectoral industry associations and other groups that are knowledgeable with respect to international technology transfer initiatives around the world.

The list of participating companies included:

Exhibitors	Technology
Acerlan, S.A. de C.V. with the Mexican Cleaner Production Centre	Foundry Process Redesign *(Mexico)*
Bono Energia S.p.a. with REDCO, Inc.	Biomass Cogeneration *(Italy/Nigeria)*
Cannon Group with Simmons	Substitutes for CFCs and VOCs *(Italy/Argentina)*
European Chemical Industry Council with the Brazilian Chemical Industry Association	Responsible Care *(Brazil)*
Global Ecology Corporation	Earthen Block Construction and Controlled Environment Agriculture *(USA)*
Hoogovens Technical Services with the Grupo Acerero del Norte, S.A. de C.V. and the Altos Hornos de Mexico, S.A. de C.V.	Steel Production *(USA/Mexico)*
K.S.V.V. Automobiles with S.V.V. Engineering Industries	Chrome Recovery and Reuse *(India)*
mt Metall-Technic GmbH with UNIDO	Artisanal Gold Mining *(Germany/Tanzania)*
Safety HiTech with North American Fire Guardian	Greenhouse Gas Substitutes *(Italy/India)*
Thermoselect S. A. with Daewoo Corporation and Kisan Corporation	Solid Waste Treatment *(Italy/Korea)*
UK Department of Trade and Industry with the Advisory Committee on Business and Environment	Technology Partnership Initiative *(U.K.)*

Exhibitors	Technology
UNEP IE in cooperation with UNEP IETC, UNCTAD and UNIDO	Internet Cafe
Universidad de Concepcion with a group of 15 Chilean fisheries	Fish Processing *(Chile)*
Vestas Wind Systems A/S with the Wind Farm at La Venta	Wind Energy *(Denmark/Mexico)*
Note: The exhibiting companies funded their own participation. In most cases, the participation of company representatives from developing countries were sponsored by their partners from developed countries. Sponsorship of the representatives for 4 of the 16 case studies have been provided by UNIDO. Not all exhibitors provided written material for the case studies in this publication.	

C. COMMUNICATIONS STRATEGY

The industry exhibits and presentations were listed on the daily schedule of events distributed to delegates. Other measures to promote interest and networking included:

A "Delegate's Guide - Kit to the Industry Exhibits and Presentations" was prepared and distributed to delegates and other participants in CSD-6; and

On-site signage regarding the program of activities was provided daily.

A media relations programme was organized in consultation with the UN Department for Public Information (DPI) and with inputs and assistance from sponsoring organizations and through a media consultant contracted for the project.

D. MANAGEMENT

The exhibits were managed by the Division for Sustainable Development of the United Nations Department of Economic and Social Affairs (UN-DESA).

PART IV: BACKGROUND PAPERS ON TECHNOLOGY

Commission on Sustainable Development
Sixth Session
20 April - 1 May 1998

Background Paper No. 20

THE TRANSFER OF ESTS : THE ROLE OF INFORMATION SYSTEMS

United Nations Environment Programme - Industry and Environment Centre

I. INTRODUCTION

1. This paper illustrates that, although dissemination and access to information have increased, there still remains persistent obstacles. Proliferation of systems offering information on environmentally sound technologies (ESTs) or related topics, varying terminology, etc., often leaves users confused and frustrated. The immense quantity of ESTs available and the lack of knowledge about how to properly assess them also hinders users from making informed choices. These problems are compounded for developing countries.

II. BACKGROUND

2. Agenda 21 identified access to scientific and technical information on ESTs as an important issue as it facilitates the transfer of technologies and strengthens the recipient country's technological capabilities. As a result, the transfer of ESTs has been an ongoing theme in the work of the UN Commission on Sustainable Development (CSD) and related intersessional meetings. The 1994 Workshop on the Promotion of Access to and Dissemination of Information on Environmentally Sound Technologies in Seoul, Korea, recommended that the United Nations Environment Programme (UNEP) undertake a survey to identify sources of information on ESTs. This was further endorsed at the 1995 United Nations Industrial Development Organization (UNIDO) Round Table on Technology Transfer, Cooperation and Capacity Building for Sustainable Development in Vienna, Austria. In response, the interim report, *Survey of Information Systems Related to Environmentally Sound Technologies*, was submitted in 1995 to the 3rd session of the CSD. This initial work was welcomed by CSD and UNEP was asked to continue the study and design a "consultative mechanism" to improve communication between information providers and users.

3. Following the CSD's recommendations, UNEP organized an expert meeting on information systems related to ESTs, in Paris, France, October 1995. This meeting addressed issues of information coverage of current information systems, needs of users, and the possible design of a consultative mechanism. Results from this expert meeting were presented to the 4th session of the CSD, which in turn invited UNEP to continue its work on developing an EST information network. The finalized publication, *UNEP Survey of Information Systems Related to Environmentally Sound Technologies,* was presented at the 5th session of the CSD in April, 1997. At the same time, UNEP launched its new PC software tool, maESTro. This software manages a Searchable Environmentally Sound Technology Directory allowing information on ESTs and associated institutions to be exchanged via a range of electronic formats. UNEP also continued to operate and update its two information clearinghouses on Cleaner Production (ICPIC) and ozone replacement technologies (OAIC) and develop a directory of directories on ESTs.

4. As the next step in improving information dissemination on ESTs, UNEP conducted a preliminary survey on user identification and feedback mechanisms (March 1997) to ascertain how information providers select their user group(s) and what methods are used to respond to user needs. The results from this current

survey served as a basis for the second expert meeting on EST information systems, held 26-28 May, 1997 in Paris, France. Much of this paper is based on the conclusions from this expert meeting as well as on-going discussions via the UNEP consultative mechanism.

III. EVOLUTION OF INFORMATION DISSEMINATION MECHANISMS

A. Hard copy and query response systems

5. With the increasing ease and availability of on-line communication, both information systems and users have greater flexibility to transmit and access information. Earlier information systems depended on hard copy (paper), dial-up systems using a computer and modem, as well as query response services as dissemination mechanisms. Improved formats and methods for presenting electronic information have augmented these dissemination media as well as making many information systems more user-friendly.

B. Electronic tools used for disseminating information

6. ***Diskettes*** allow for information to be disseminated in a compact, simple format with users needing relatively little computer equipment and software. Often they are used for searchable directories where users can look for information by subject category, key word or geographical location. Both UNEP's International Cleaner Production Information Clearinghouse (ICPIC) and the OzonAction Information Clearinghouse use diskettes to disseminate information on available technologies, technical literature abstracts, policies, experts and consultants. UNEP's YELLOW PAGES is a resource guide which provides information on international directories and trade shows that describe ESTs and associated services.

7. ***CD ROMs*** are quickly replacing diskettes as "free standing" information packets. They offer the advantage of holding more information than a diskette, processing information faster, and allowing for a higher degree of interaction. Currently, CD ROMs are being used to disseminate information on available services, products, technologies etc., as well as to teach people a particular skill, i.e. an education tool. For example, Environment Canada, Industry Canada and the European Union have each produced a CD ROM on available ESTs and related services in their region. These products offer the user the choice of searching for information either by products/services, company name or environmental category, e.g. air pollution, waste water treatment, etc. All entries are indexed and cross-referenced although they are not "on-line". The GREENTIE CD ROM, co-produced by the International Energy Agency (IEA) and the Organisation for Economic Cooperation and Development (OECD), was created to support the Framework Convention on Climate Change (FCCC). It contains profiles and contact details of suppliers of greenhouse gas technology expertise and equipment.

8. ***Internet*** is currently the most common form of on-line, electronic dissemination. Here, organisations, associations, governments, academic and research institutions, etc., produce a **website** to promote their activities and products. Some design their website to be an electronic clearinghouse, i.e. disseminating information, documents, responding to queries, etc. Other sites are used more as an electronic brochure, describing activities and available resources in a summarised format. With increasing awareness of environmental issues, the number of "environmental" websites has skyrocketed with sites ranging from soft-impact living philosophies to technologies on pollution prevention. Sites also augment their information by "linking" to other related sites. Some sites provide direct links to the relevant, corresponding page of a new site instead of linking to the home-page. This avoids the user having to perform a new search for the relevant information.

9. The increase in websites has spawned what are called **meta-sites** or "umbrella" sites. These initiatives are frequently sophisticated pointer systems that provide overviews and contact information on other websites or information systems providing assistance on a common topic. For example, Japan's APEC

Virtual Centre for Environmental Technology Exchange is a pointer system which provides links to websites offering information on issues, services, companies, discussion forum and activities of local government in the Asia-Pacific region, concerning environmental technologies. UNEP's maESTro on-line database provides users with institutions, global, regional and national EST information systems, as well as ESTs in urban and freshwater management. maESTro also allows for data exchange where users can upload relevant information on ESTs which is then incorporated into the database.[1] Another meta-site (US-AEP) offers overviews of US associations, academic institutes and standards institutes that work in the Asia-Pacific in the field of clean technology, environmental management, urban policy and related issues. Brief information about the various organisations and corresponding hyperlinks to each organisation's website are included.

10. The US-AEP site can also be considered an **electronic intermediary.** Associated with the site are US Offices for Technology Cooperation where representatives can help US technology manufacturers identify market opportunities, and assist in making key contacts. For companies looking for solutions to environmental needs, the representatives serve as matchmakers by facilitating contact between manufacturers and potential users as well as acting as environmental experts. The European Union's pilot project - EDDY (Environmental Data Directly to You) is another version of an electronic intermediary. Although there is no actual contact with a representative, the system is designed to provide information to SMEs on European programmes and opportunities for business contacts based on parameters specified by the user. Companies design a profile of their information needs and on the basis of this profile, EDDY sends information to the companies via E-mail messages and attached files at the requested frequency. The requirements for using this system is a computer and modem. Initial contact with EDDY is via the Internet.

11. ***Electronic networking*** is yet another medium for information exchange. Here, experts in a particular field exchange information and ideas via an E-mail list service (listserv). This discussion forum provides an opportunity to build cooperation and keep participants abreast of new developments. Currently, there are numerous networks which focus on the various aspects of information dissemination of ESTs. For example, UNEP Industry and Environment Centre established a listserv *(EST Info)* to continue the work of the May 1997 *Expert Meeting on Information Systems Related to Environmentally Sound Technologies.* Here, participants can correspond on matters related to ESTs and provide feedback on projects and papers such as this one. However, unless the system is intensively managed, interest and use often decline.

IV. REMAINING CHALLENGES

12. There is no question that the Internet and other electronic tools like CD ROM allow for greater dissemination of information. However, what is not clear is how well the information is targeted and its usefulness. With governments, convention secretariats, private companies, etc. all involved in information brokering, it is increasingly difficult to sift through the quantity of information available. For information to effect change, it must respond to users' needs (or be educative), reach the intended users and be usable by users. However, even with this information "boom", feedback from discussions and surveys indicate that there is still a noticeable gap between the information available and the users' knowledge of it. Moreover, many information systems are developed by the industrialised countries for users in those regions, meaning that information may have little relevance to developing countries. **Below are five key issues that need to be addressed if successful information transfer is to occur.**

[1] This database is also available on CD ROM or in hard copy

A. Enhancing the quality of information disseminated

13. *The nature and quality of information on ESTs disseminated is driven by various factors:*

(a) Vendors of ESTs and governments, wishing to promote technologies developed in their own countries, have been the primary drivers in setting up information databases. As a result, the information provided is not always objective and complete. Furthermore, these databases focus predominately on end-of-pipe technologies.

(b) Lack of consensus on what defines an EST compounds the problem. Some technologies considered "environmentally sound" several years ago are not seen as such today, e.g. waste incineration. In addition, the majority of information on ESTs is actually information on end-of-pipe technologies. While these technologies do play a role in pollution control, they do not address the key issues of pollution prevention and the efficient use of raw materials. There is also a general difficulty in identifying "clean" or "cleaner" technologies as their environmental impact varies on how they are employed.

(c) Increased use of the Internet as a dissemination mechanism affects the quality of information on ESTs. Using 2 of the 14 major search engines, a preliminary search on the Internet using the phrase "environmentally sound technologies" yielded over 2,000 hits. A sampling of these hits illustrated a wide range of sites, most of them offering general environmental information with little substance on ESTs as defined in Agenda 21.[2] Therefore, although there appears to be comprehensive information on ESTs, much of the information is duplicated, peripherally related or collected under the EST heading because it contains references to "environment" and/or "technologies".

14. The use of different terminology by information systems to describe ESTs (even if the technologies themselves perform the same function) further compounds the problem. As a result, a search using only one of the various terminologies does not provide a comprehensive listing of available sites. One example is the concept of pollution prevention. In order to obtain an appropriate sampling of available sites on this subject, the following search words have to be used: pollution prevention, cleaner production, eco-efficiency, waste minimization, sustainable industrial development, and industrial ecology. The majority of users are not aware of the extent of multi-terminology and, therefore, are not able to access fully the available information. This gives the appearance of "gaps" in the information "net". The tendency is to create new websites to fill the perceived "gap", resulting in an increase in websites and redundancies in the information.

B. Providing an integrated approach for evaluating ESTs

15. Information systems have been, and are currently being developed, to respond to government officials' and industry managers' need for information on specific environmental issues, e.g. waste treatment, water treatment or to implement the various international conventions,[3] etc. As a result, information systems are often one dimensional in their description of a technology, i.e. the description does not include considerations of broader environmental issues such as emission of greenhouse gases, raw

[2] According to Agenda 21, environmentally sound technologies (ESTs) *"protect the environment, are less polluting, use all resources in a more efficient manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they are substitutes".* ESTs include, not only the hardware, but also the know-how, services, and managerial skills to make them work.

[3] For example, the Montreal Protocol for the Protection of the Ozone Layer, Convention on Marine Protection, Basel Convention on Hazardous Waste, Framework Convention on Climate Change, etc.

resource and energy consumption, production of hazardous waste, etc. Therefore, the impact of a specific technology on the environment as a whole is rarely addressed. One example is the replacement of ODS refrigerant by a non-ODS ammonia-based refrigerant. While this replacement meets the requirements of the Montreal Protocol, poorly designed systems that use ammonia increases the chance of worker exposure to ammonia leaks. Similarly, some substitutes of ozone-depleting substances contribute to the greenhouse effect.

C. Identifying users and clarifying their needs

16. In preparation for its 2nd *Meeting of Experts on Information Systems Related to Environmentally Sound Technologies*, UNEP conducted a preliminary survey on user identification and feedback mechanisms. Given the wide range of user groups identified in the survey[4], information systems only have a general idea of who their user groups are. This heterogenity of user groups poses an interesting question: does serving a large number of user groups undermine the quality of information that a system provides? A system with a wide range of users must present the information in a form that is accessible to all its users. While maximizing access means that more people can use the information, often the information is too general to be used effectively by users with sector-specific needs. A common consequence of this "broad outreach" approach is that the focus of an information system becomes diffuse.

17. One reason many information systems are supply-driven is because users themselves frequently have poorly defined needs and, therefore, cannot articulate them. This is compounded by users' unrealistic expectations about what information systems can provide. While systems can offer a range of information, the majority of them are not designed to generate answers to specific user questions. Some information systems with better resources and a certain commitment to this "user-tailored" approach have attempted to provide such a function in the form of a query-response service. However, the majority of systems provide a resource-based service where the collected information provides *guidance* to defining and solving a problem. Therefore, users' expectations must also change if the gap between information dissemination and its use is to be narrowed. More efforts should be spent on educating users about the types of questions to ask rather than on designing additional information systems to answer the expanding range of needs.

D. Improving information access for Small and Medium Sized Enterprises (SMEs)

18. Although the Internet allows for increased, rapid access to information, it does not necessarily mean an increase in information dissemination. In fact, dependence on the Internet for reaching certain users could result in a decrease in information transfer. A study conducted by the European Union and UNEP[5] on SMEs revealed that due to their small size and lack of resources, information dissemination was most effective via one-on-one contact, group presentations and hardcopy. Therefore, dependence on electronic dissemination for reaching SMEs will unlikely have an impact. Given the fact that SMEs account for a large percentage of economic activity, and hence an environmental impact, it is important that information reaches them in a usable format.

---

[4] Out of the 33 returned questionnaires (total distribution = 52), over 50% of the systems serve 8 or more major groups. At least 30% of information systems serve 12 or more user groups. The 12 major users groups identified by the surveyed information systems were: academia, industry, government, non-governmental, large businesses, small and medium businesses, research institutes, consultants, regulatory agencies, the UN, towns and city administrations.

[5] The report is titled *"Developing Better Systems for Communication - Environmental Best Practises in Business"* and is available from UNEP IE.

19. While there are a number of Internet sites that provide information targeted at SMEs, in general - SMEs do not consult the Web for information. For information to reach these important users, intermediaries such as suppliers, business organisations, municipal authorities, social groups, e.g. Rotary Club, are necessary. Information also flows horizontally between SMEs, meaning that businesses trust information coming from other businesses over that from "un-tested" information systems. Information on how changes will affect their bottom line is also important in influencing SMEs to change their behaviour.

E. Developing good feedback mechanisms

20. Although many systems try to communicate with their users to assess user needs, the feedback mechanisms are usually labour-intensive, expensive and do not permit direct interaction with users, e.g. newsletter, annual reports, bulletins, etc. The result is that the information systems do not have a real understanding of their users' need. The fact that users are not clearly identified also encumbers the feedback process.

V. RECOMMENDATIONS FOR ACTION

21. The following recommendations are based on the analysis above.

Information providers need to understand the on-going needs of the target audience

22. A target audience can generally be divided into general and specialized users. General users, e.g. government, environmental groups, labour, community groups, educational institutions, usually require information that conveys broad characteristics or trends as opposed to technical specifics. Often, they are looking for ideas and options. Language should be simple and it is best to use existing delivery channels such as the Internet, newsletters, etc. For specialized users, e.g. intermediaries or consultants, information and delivery mechanisms must be customized. This requires information systems to have identified, at the outset, the needs of the users and any dissemination barriers. Specialized users want greater detail, quantitative information and costs.

23. Regardless of the target audience, the delivery mechanism should allow for two-way communication between provider and user. A feedback mechanism will help systems be more user- rather than supply-driven. Ideally, the delivery mechanism should also have an educational component. For example, some users are unsure about what their needs are, or do not know how to incorporate the information into the decision making process. Thus, information systems should be able to help users further identify their needs and indicate where, or how the information can be used in the decision-making process.

Information providers should work with intermediaries to identify user needs and to improve information dissemination

24. Identification of user needs can be best done through the use of intermediaries that are in *direct* contact with the final users of information. Here, intermediaries can be national technology centres, consulting firms, industry associations etc. The value of these intermediaries is their ability to search, collect, select and interpret the information for a particular audience. The direct interaction between intermediary and user is also valuable. The intermediary helps the user define his/her needs as well as acting as a feedback channel to information systems. As intermediaries are one solution to narrowing the communication gap between suppliers and users, efforts should be spent on strengthening their role in the information exchange process.

25. Intermediaries are especially important in reaching SMEs as the most effective way to reach and change their behaviour is through personal contact. Personal contact made through existing, trusted routes of information dissemination are the best path to follow. However, the routes of dissemination or sources

of information will differ, depending on the culture and nature of the geographical location, and type of industry sector. More importantly, the need or demand within SMEs for the information must be established or it is difficult to obtain and maintain SME interest.

26. The challenge is to identify the existing mechanisms that have access to SMEs and to use them to deliver a simple, clear, message that highlights economic benefits, easy-to-do actions and where to go for more assistance. This means that information (electronic or otherwise) has to be targeted at the intermediaries, not the SMEs themselves. These intermediaries will vary greatly and, therefore, information systems must have a good understanding of who they are and how best to target them.

A network of integrated clearinghouses to provide information on ESTs should be developed

27. In order to make environmentally sound decisions, decision makers in government and industry need consistent, unbiased information which outlines the various environmental implications of their choice. This need can be addressed by the development of a clearinghouse network built on already existing information systems. This network should develop standardised technology descriptors to help decision makers compare technologies and associated environmental implications. The information disseminated by these clearinghouses should also provide information to governments and industry to help with the implementation of UN Conventions, e.g. information on whether a technology produces greenhouse gases (Framework Convention on Climate Change), or hazardous wastes (Basel Convention), etc. Health and safety criteria should also be addressed as the replacement of one technology by another can have negative implications for worker health and safety.

Strengthen the international consultative mechanism set up by the CSD to improve and link existing information systems

28. To improve the quality of information on the Internet, information systems need to focus on their areas of strength and augment their services by linking with other information systems that have complementary information. This is particularly true of information systems that use the Internet as their primary dissemination mechanism. Systems should focus on what is not available and provide direct links to corresponding pages of existing systems that provide supporting information. This will minimise redundancies. However, the increase in the number of links per website means that the information search process can quickly become confusing and overwhelming. Meta-systems ("umbrella" systems) can play a role here by gathering websites together that focuses on a common theme, e.g. Cleaner Production, energy, mining, etc. These meta-sites can then provide a road map for the linked sites and a brief synopsis of each one. While the ease of use and efficacy of such a system depends on the structure and selection criteria, this is one way to improve the efficiency of existing information sources and strengthen their complementarity. The addition of an "electronic research assistant" can help the multi-terminology issue mentioned earlier. This electronic tool guides the user by helping him/her refine and narrow down his/her query. The ability of this engine to recognise different terminologies for the same subject matter would also improve the quality of the search.

VI. CONCLUSION

29. Although information dissemination of ESTs is increasing, there continues to be barriers to its application. The issue is not the lack of, or difficulty in accessing information, but rather a disjuncture between the information supplied and its demand. There is also a need to improve the links between information systems as well as to develop better complementarity in the information provided. In addition to improving the information flow, users must be better educated in how to find, understand and apply information so as to make the best choice, given their specific needs and environs. This is particularly the case with developing countries. It is knowing how to apply the information, rather than the information itself, that is the key to the transfer of ESTs. Finally, needs for information are evolving. Several years ago,

the demand for information was not focused. Today, governments and industry managers are asking for information, not only about generic ESTs, but also about comparative costs and performance of specific ESTs, necessary management and maintenance systems, etc. This continually evolving demand for information reinforces the need to strengthen the consultative mechanism on information systems, initiated by UNEP at the request of CSD.

Commission on Sustainable Development
Sixth Session
20 April - 1 May 1998

Background Paper No. 22

THE ROLE OF PUBLICLY-FUNDED RESEARCH AND PUBLICLY-OWNED TECHNOLOGIES IN THE TRANSFER AND DIFFUSION OF ENVIRONMENTALLY SOUND TECHNOLOGIES

United Nations Conference on Trade and Development[1]

I. INTRODUCTION

A. Background

1. The objective of this study, prepared with the generous support of the Republic of Korea, is to take stock of the role, scope and relative importance of publicly funded research and development (R&D) in the generation of environmentally sound technologies (ESTs). In this context, the study explores the feasibility of implementing relevant provisions under Agenda 21, reviews existing policies, including legal and institutional issues, and suggests possible policy options and initiatives. Its findings were discussed at the International Expert Meeting on the Role of Publicly Funded Research and Publicly Owned Technologies in the Transfer and Diffusion of Environmentally Sound Technologies, organized by the Government of the Republic of Korea, and held in Kyongju from 4 to 6 February 1998. The results of this meeting are being made available to the sixth session of the Commission on Sustainable Development (CSD), to be held in New York in April 1998.

2. The study was a cooperative effort of the United Nations Conference on Trade and Development (UNCTAD), the Department of Economic and Social Affairs of the United Nations (DESA) and the United Nations Environment Programme (UNEP). It was prepared pursuant to recommendations of the Commission on Sustainable Development, at its fifth session, which concluded that:

> "A proportion of technology is held or owned by Governments and public institutions or results from publicly funded research and development activities. The Government's control and influence over the technological knowledge produced in publicly funded research and development institutions open up a potential for the generation of publicly owned technologies that could be made accessible to developing countries, and could be an important means for Governments to catalyse private sector technology transfer. Proposals for the further study of the options with respect to those technologies and publicly funded research and development activities are to be welcomed".[2]

3. The application of new, resource-efficient and clean technologies holds a key to environmental sustainability at both national and global levels. In this context, the adoption of ESTs is essential for

[1] This paper was prepared by the UNCTAD secretariat in cooperation with the Division for Sustainable Development of the United Nations Department of Economic and Social Affairs (UN DESA) and the United Nations Environment Programme (UNEP) as background document for the International Expert Meeting on the Role of Publicly Funded Research and Publicly Owned Technologies in the Transfer and Diffusion of Environmentally Sound Technologies, held in Kyongju, Republic of Korea, 4-6 February 1998.

[2] Paragraph 91, "Programme for the further implementation of Agenda 21", adopted by the General Assembly at its 19th special session, 23-27 June 1997.

countries in order to maintain a balance between the objectives of development and those of the environment. Facilitating the use of ESTs in all countries calls for a combination of measures involving a broad coalition of institutions from the public and private sectors. Technology transfer to developing countries has traditionally been a complex and critical issue, which has not been resolved satisfactorily at the international level. However, with regard to ESTs, the stakes are higher compared with other areas, given the urgent nature of global environmental degradation and the degree of international commitments reflected in the discussions and agreements at the United Nations Conference on Environment and Development (UNCED) in 1992 and at the "Rio+5" meeting, held in New York in June 1997.

4. All major international agreements addressing global environmental problems, ranging from the Convention on Biological Diversity to the United Nations Framework Convention on Climate Change, and particularly the Montreal Protocol and its amendments, contain specific provisions regarding legislative, administrative or policy measures for access to and transfer of technology.[3] This is in line with the international recognition of "global commons", "intergenerational equity"[4] and the fact that economic development and environmental degradation are closely linked.

5. According to the World Resources Institute, technological transformation is a primary strategy for avoiding further environmental degradation. It is argued that "widespread, continuing development and adoption of ever less polluting and more resource-efficient products and services"[5] would be able to contribute to the expansion of wealth and productivity, and at the same time hold a key to environmental sustainability.

6. In several industrialized countries the development and diffusion of environmentally sound technologies has clearly contributed to innovation and the strengthening of economic competitiveness.[6] Governments that have recognized the dual purpose and importance of ESTs have put considerable public resources and finances into R&D activities that may result in the development of such technologies. Nevertheless, the expectations raised at Rio for a rapid diffusion of ESTs to all parts of the world, including developing countries and countries in transition,[7] have not been fully realized.

7. Within the United Nations, the discussion on the use of publicly funded R&D and publicly owned technologies for environmental protection measures in recent years sometimes focused on the conversion of military R&D to civilian use. Thus, a report by the Secretary-General of the United Nations proposed, *inter alia*, that the technological capabilities of military establishments including their R&D endeavours, laboratories, equipment and expertise, be utilized for measures designed to protect the environment.

---

[3] See chapter III for details.

[4] For a detailed discussion of these fundamental questions, see Edith Brown Weiss, In Fairness to Future Generations: International Law, Common Patrimony and Intergenerational Equity, New York, Transnational Publishers, 1988; and *Environmental Change and International Law*, Tokyo ,United Nations University Press, 1992.

[5] George Heaton, Robert Repetto and Rodney Sobin, *Transforming Technology: An Agenda for Environmentally Sound Technology in the 21st Century*, Washington, D.C. World Resources Institute, 1991, p. ix.

[6] Moreover, these technologies have often stimulated other technological areas. See, for example, the analysis of the economic, ecological and legal implications of over 1,400 publicly funded ESTs in Germany: BMBF, *Wirkungen der Förderung von Umwelttechnologie durch das BMBF*, Frauenhofer-Institut für Systemtechnik und Innovationsforschung, Karlsruhe, January 1997. See also the discussion of the economic potential of ESTs in E. U. von Weizsäcker et al., *Faktor Vier*, Münich, Droemer Knaur, 1996.

[7] For the expectations raised prior to Rio, see, for example, the proposal for a "Strategic Environmental Initiative" made by Al Gore: Al Gore, *Earth in the Balance*, Boston, Houghton Mifflin, 1992.

Particular attention was paid to the reallocation of skills and capabilities with regard to "dual-use technologies" from military to environmental tasks in areas such as environmental monitoring, chemical analysis, cartography, medicine, microbiology and radiology.[8] The broad spectrum of the technological capacities mentioned in the area of defence-related R&D in that report provides some indication of the potential range of publicly funded technologies in other areas. However, so far, no systematic effort has been made to explore the potential that publicly funded R&D could offer in the generation, diffusion and transfer of ESTs.

8. The identification of appropriate mechanisms for the transfer of ESTs raises a number of issues. First, it is not known to what extent publicly funded R&D leads to the generation of ESTs and whether such technologies meet the specific ecological needs of all countries, particularly developing countries. Second, it is not clear under what conditions such technologies could be successfully transferred to third parties. Third, there are no readily available mechanisms through which publicly funded technology could be transferred to developing countries. These issues will be addressed below.

B. Methodology

9. This study draws on a number of case studies as well as a preparatory review meeting involving the three cooperating agencies and a selected number of experts. Country case studies included studies on Brazil, Canada, the Czech Republic, France, Germany, India, Japan, the Republic of Korea, the United Kingdom and the United States. This selection represents countries with developed and developing economies, as well as one country with an economy in transition, which are important producers and consumers of ESTs. Furthermore, three additional studies -- on the United States, France (including the European Union framework) and the MERCOSUR countries -- were carried out on selected policy and institutional issues dealing with the transfer and commercialization of ESTs. In an attempt to gain a better understanding of the role of supporting institutions in the generation of ESTs, a review of publicly funded R&D in universities was also prepared, using as an example leading universities in the United States. Existing provisions under multilateral environmental agreements are only briefly described, since they do not specifically refer to publicly funded or publicly owned ESTs.

10. The concept of technology applied by this study includes knowledge embodied in machinery and equipment, knowledge codified in patents and blueprints as well as tacit knowledge, including the special routines, practices and know-how to manage production processes. In much of the literature, technology "diffusion" refers to the wider utilization of technology, while "transfer" refers to technology that affects production and to its transmission to another party. In the international debate, there has sometimes been a notion that differentiated between the "transfer" and "commercialization" of technology. In this understanding, "transfer" was seen as a direct, even costless or preferential provision of technology, whereas "commercialization" of technology involved the sale or licensing by the owner or producer of it. As illustrated by the country case studies, governments today often equate "commercialization" with the transfer of technology.

11. As highlighted by the country case studies, there are no commonly accepted definitions of "ESTs", although there are generally recognized features of environmentally sound technologies, and an increasing

[8] United Nations, *Report of the Secretary-General on General and Complete Disarmament: Charting Potential Uses of Resources allocated to Military Activities for Civilian Endeavours to Protect the Environment (*A/46/364), 17 September 1991. Compare also the UNCTAD study carried out for the Commission on Science and Technology for Development: United Nations, Economic and Social Council, Commission on Science and Technology for Development, second session, *Scientific and Technological Aspects of the Conversion of Military Capacities for Civilian Use and Sustainable Development* (E/CN.16/1995/13), 3 March 1995.

recognition that these distinguish them from other technologies.[9] It should be noted, however, that because of the evolving nature of environmental problems, ESTs have dynamic features in that what might be perceived as environmentally sound today may not necessarily be sound tomorrow. Equally, any technology must be viewed in its socio-economic and cultural context. Thus, what is environmentally sound technology in one country may not be so in another.[10] Providing an exact definition of ESTs is, at this stage, neither helpful nor desirable.[11] For the purposes of the present study:

> "The terminology 'environmentally sound technologies' refers to 'clean' technologies which are low in impact on the environment in terms of pollution and/or high in energy-efficiency compared to other technologies currently in use. Often, ESTs are being introduced to alleviate the adverse impact of development on the environment. ESTs may be categorized as follows:
>
> - end-of-pipe technologies designed for the treatment of pollution;
>
> - remedial technologies aimed at cleaning up damage or reclaiming resources that were formerly degraded;
>
> - process technologies producing goods or services with lower resource consumption or waste generation;
>
> - product technologies involving environmental improvement through altered final or intermediary products which are less polluting and recyclable."[12]

12. In the context of this study, *publicly funded ESTs* are understood as those that are generated from R&D activities sponsored by the public sector. The results of publicly funded R&D may be disseminated through public institutions or private firms, or a combination of both. The ownership structure, as is shown in this study, sometimes involves complex models that include both government and the private sector.[13] In carrying out this research work, answers to the following questions were sought:

- What is the extent of public sector financing for R&D activities?
- What are the range and types of ESTs developed as a result of publicly funded R&D activities?
- How are these technologies diffused or/and commercialized at the national level?

---

[9] Chapter III elaborates on this point.

[10] See, "Environmentally sound technology for sustainable development", *ATAS Bulletin*, no. 7, United Nations, New York, 1992.

[11] Nevertheless, some agencies have attempted to provide information on the range and types of ESTs available. See, for example, figure 2 in the present study.

[12] Quotation from project document.

[13] Publicly owned technology is clearly differentiated from technology in the public domain. Publicly owned technology is the product of publicly financed R&D, whether or not it is protected by intellectual property rights, while technology in the public domain is formally proprietary technology whose intellectual property protection has already expired or which never received or was never eligible for protection. The results of *publicly funded R&D* may be publicly or privately owned technologies or involve complex combinations of ownership. Most of this document will deal with publicly funded R&D, while the concept of public ownership will be referred to, but -- overall -- remains somewhat elusive.

- To what extent are these technologies appropriate to third countries?
- What mechanisms are required to facilitate the effective transfer of such technologies to developing countries and economies in transition?

II. PUBLICLY FUNDED R&D IN THE GENERATION OF ESTs

13. This chapter provides data on the first two of our five basic questions (paragraph 12). Section A contains an overview of publicly funded R&D using data from OECD sources[14] and from the country case studies unless otherwise stated. Data in section B rely mainly on the case studies undertaken for this study.

A. The General Extent of Public Sector Financing in R&D Activities

14. The country case studies demonstrate that public funding remains a major source for R&D activities, although in most countries in which case studies were conducted, government's share in gross domestic expenditure on R&D has been declining in recent years.[15] However, this relative decline should not conceal the fact that it remains important in the countries under consideration (see figure 1). Moreover, in some countries in which the government's share in total R&D spending has traditionally been low when compared with the private sector (Japan, Republic of Korea) it appeared to be increasing in the early 1990s. In the Czech Republic, the one economy in transition that was part of this study, public funding for R&D is rising again after having experienced a steep decline. Finally, public, as compared with private, R&D support tends to be considerably higher in developing countries than in developed countries (over 80 per cent in one case).

Figure 1: The relative importance of R&D spending by governments (1993-1995)

R&D/GDP	*Government share in total R&D expenditure*		
	High > 66 per cent	Medium 33-66 per cent	Low < 33 per cent
High > 2.5 per cent		Germany United States	Japan
Medium 1-2.5 per cent		France Canada	United Kingdom Rep. of Korea
Low < 1 per cent	Brazil India	Czech Republic	

15. Governments, in general, are convinced that public support to R&D is important for ensuring a competitive economy, and emphasize this fact in public policy statements.[16] Several of our country case studies testify to this. Such statements are not mere rhetoric, as governments do follow up with public

[14] OECD, *Industry and Technology Outlook*, Paris, 1996; OECD, *Science, Technology and Industry Scoreboard of Indicators 1997*, Paris, 1997.

[15] It was, however, often increasing in absolute dollar terms.

[16] R&D continues to include scientific activities which may be neither directly nor necessarily related to competitiveness, but many public statements emphasize the latter.

financing of R&D and with setting priorities among different technological areas. Even in countries that emphasize the predominant role of private initiative, political commitment to provide support to "key technological areas" such as information and communications technology remains strong.

16. All the developed countries provide direct support to R&D carried out in the private sector as well. On average, the rate of public-public *versus* public-private support in these countries remains constant, i.e. a decline in the overall support to public R&D institutions was paralleled by a decline in direct public R&D support to private companies. In developing countries, public R&D support continues to go predominantly to public institutions.

17. Public funding of R&D usually takes one of two forms: general support to national R&D institutions and laboratories that perform research in areas according to their mandate and designation, or direct funding of specific projects according to set government priorities. The latter could be carried out in public institutions, universities, both public or private, or in private companies. In some countries, in addition to the federal government, state or local governments provide substantial funding to R&D (e.g. Brazil, Germany, Japan and the United States).

18. On average, over the past decade, up to 40 per cent of annual national R&D spending within a number of OECD member States was publicly funded (see appendix I). The average of national public sector spending on R&D for the 15 EU member countries in 1993 was 39.7 per cent. The equivalent figures were 39.6 per cent for North America, 19.6 per cent for Japan and 36.2 per cent for the OECD as a whole.[17] While 1995 figures were lower (but higher for Japan), they remain significant: 34.5 per cent for the OECD countries as a whole, 36.1 per cent for the United States, 33.1 per cent for the EU and 22.4 per cent for Japan.[18] A high percentage of the finance for R&D activities in a number of developing countries also originates in the public sector.[19] Figure 1 summarizes the relative position of the ten countries covered in this study with respect to the share of R&D in gross domestic product (GDP) and the share of public funding in gross domestic expenditure on R&D (GERD).

19. Data available on total expenditure on R&D for OECD countries indicate that the rate of growth has declined in North America, the European Union and the Asia-Pacific region, causing the overall OECD R&D expenditure as a percentage of GDP to fall slightly from 2.3 per cent in 1985 to 2.2 per cent in 1993. The slight decline in overall R&D expenditure and the more pronounced decrease in the share of government funding of R&D in some OECD countries can be partially explained by a decline in defence-related R&D activities. But public sector funding of R&D in general has also come under closer scrutiny. Nonetheless, as the case studies conducted reveal, the role of the public sector as a source of direct funds for R&D activities remains significant. In addition, governments in many countries play an indirect role in funding corporate R&D, for example through the allocation of preferential financing and through tax incentives.

20. All country case studies provide details on the institutional framework that has been established to coordinate, guide, control and channel public R&D funding to the scientific community in the public and private sectors. For example, in Canada, these institutions range from the National Research Council to Networks of Centres of Excellence. In the United States, national laboratories play a central role in publicly funded R&D alongside public institutions such as the National Science Foundation that provide funding to public and private universities. In Japan, public assistance for R&D supports the work of laboratories of national universities as well as specialized public R&D institutes. In the Republic of Korea, there are various

[17] OECD, *Science, Technology and Industry Outlook 1996*, Paris, 1996, p. 239. Data are for 1993.

[18] OECD, *Main Science and Technology Indicators 1997*, Paris, 1997.

[19] Details for developing countries may be found in UNESCO, *World Science Report 1996*, Paris, 1996.

government-supported technology development programmes conducted by ministries and government agencies. These are programmes available to private industries and academic communities, designed to promote technological innovation in general. In the Czech Republic, the Academy of Sciences, although downsized, continues to play a central role in public R&D. The two studies carried out under this project in developing countries, Brazil and India, provide detailed evidence of government R&D programmes and institutional capacity-building.

B. The role and relative importance of publicly funded R&D in the generation of ESTs

21. This section focuses on the significance of publicly funded R&D in the development of ESTs and the range and types of ESTs developed as a result of publicly funded R&D activities. It also assesses the extent to which the ESTs generated as a result of publicly funded R&D meet the needs of developing countries and countries with economies in transition.

22. The findings of the country case studies show that the role of publicly funded R&D in the development of ESTs is vital. However, isolating the data regarding the ratio of public funding for R&D earmarked for ESTs proved to be a tedious exercise in many of the case studies. Even in the few countries that explicitly list technologies for "environmental protection" as a separate category of funded R&D, this category covers only a small percentage of ESTs. Other ESTs are found in fields as diverse as alternative energy technologies, ecologically benign agricultural technologies or technologies related to waste reduction.

23. Thus, in spite of the frequent use of the term "ESTs" in international forums and multilateral environmental agreements, the concept remains elusive at the national level. This point is highlighted by the Brazilian study, which notes that:

> "The concept of ESTs is ... very little understood in all institutions visited or contacted. Both in research institutes and in government agencies responsible for devising and implementing environmental and S&T policies, the technicians have difficulties in conceptualizing ESTs. This obviously creates predictable difficulties in the classification of projects whose objective is the direct or indirect development of technologies being considered in this study."

Nevertheless, a notional idea of technologies that can be classified as ESTs does exist. The UNEP typology presented in figure 2 illustrates such an approach.

Figure 2: Example of a typology of ESTs (Source: UNEP)

Water pollution control and water supply	Technologies for water and wastewater treatment, water supply and water resources management
Air pollution control	Technologies for the control and treatment of air pollution emissions (NO_x, SO_x and CO -- excluding greenhouse gases)
Noise and vibration protection and abatement	--
Solid waste management	Technologies for collection, transport, storage, treatment, recycling and disposal of solid waste
Hazardous waste management	Technologies for collection, transport, storage, treatment and disposal of hazardous waste

Figure 2: Example of a typology of ESTs (Source: UNEP)

Energy	Technologies for alternative and renewable energy supplies and for energy conservation
Cleaner production	Integrated preventive environmental strategies for processes and products to reduce risks to humans and the environment
Land and agriculture	Technologies related to the sustainable development and conservation of land, agriculture and natural resources, including land remediation, soil conservation, mineral extraction, biodiversity, agro-chemicals, sustainable agriculture and afforestation
Construction, building and engineering	Technologies related to engineering, infrastructure development and building construction (the latter including machinery, equipment or methods/techniques of construction) which are environmentally sound
Global environment	Technologies for reduction of greenhouse gas emissions, mitigation of global warming and alternatives to ozone-depleting substances (ODS)

24. The case studies show that the role of the public sector in the financing of R&D activities related to the generation of ESTs in this broad sense is considerable. The modalities of public sector financing of such activities vary between countries. There are also variations in the policies that governments have adopted as regards financing of the generation of ESTs. Some governments have developed clear policy guidelines not only on R&D financing, but also on the innovative activities required by recipients of such funding and the specific target areas requiring ESTs. In contrast, one finds countries where the public sector is to some extent active in environment-related R&D, but does not provide clear policy guidance. Thus, several country studies found that while government support programmes for the environment industry did exist, coordinated efforts for the development, growth and market access of environmental technologies and services were lacking.

25. The multifaceted nature of ESTs makes it difficult to provide accurate data on the proportion of public sector funding of R&D activities which are directed at ESTs. However, estimates of some components of ESTs are available. One source estimates the ratio for energy research at 5.5 per cent for Canada, 3.9 per cent for France, 20.5 per cent for Japan and 4.2 per cent for the United States.[20] Public R&D spending directly classified as targeting "environmental protection" is 0.6 per cent in the United States and 4.2 per cent in France and Germany.[21] In Germany, the share of federal funding targeted at EST-related R&D activities in total federal R&D expenditures was 2.25 per cent in 1996. This marks an increase from 1.67 per cent in 1990. However, these figures do not include funds earmarked for other EST-related activities in fields such as energy research and energy technology, innovation and improvement in basic conditions. Nor do they include EST-related R&D financed by the State Governments (*Länder)*. In India, 4.1 per cent of the entire 1994-1995 R&D expenditure was spent on protection of the environment.

26. Translating the above percentage numbers into absolute figures reveals a considerable amount of public R&D spending. According to the OECD, many of its member States began to sponsor R&D programmes

[20] OECD (1997).

[21] Rolf G. Sternberg, "Government R&D expenditure and space: Empirical evidence from five industrialized countries", in *Research Policy*, 25, 1996, pp. 741-758 (here: p. 742).

for cleaner technologies in 1989 and 1990.[22] By 1992, these programmes alone were investing over US$1.5 billion and growing rapidly. The programmes ranged from funds directed at advanced and engineering development of cleaner production and products to major process changes. The commercialization of these government-assisted cleaner technologies is deemed successful.

27. The country case studies reveal that a range of ESTs that could meet the needs of developing countries and economies in transition appear to be available in both developed and developing countries. In India, for example, publicly funded ESTs are found within a range of each of the following classifications: chemicals and allied, marine chemicals, plastics, resins, paints, insecticides, pesticides, agro-based, food processing, drugs and pharmaceuticals, leather processing, metallurgy, building and construction, mechanical engineering, instruments and devices, electrical, miscellaneous, and others. In Germany, the range of publicly funded ESTs which could also meet the needs of developing countries include the development of environmentally more friendly automobiles and a traffic management system for urban areas, the application of biotechnology for arid areas, the optimization of animal feeding and water management systems for mega cities in developing countries, and technologies for treatment and utilization of wastes.

28. Many countries included in the study have established national institutions or ministries designed to coordinate environmental activities, including those related to technology. In Canada, the Environment Technology Centre (ETC) of Environment Canada was established as long ago as 1975 to provide specialized technical and R&D support for the department's activities. In Germany, environmental aspects, particularly environmental protection, are major criteria in taking decisions on research funding. The German study shows that partly because of a reduction in public resources available for R&D activities, the Government is now following an "integrated research approach" whereby research strategies are formulated in close collaboration with private enterprises, taking into account the needs of global markets and the export opportunities for German enterprises. To that end, R&D pilot projects in areas where German enterprises have a comparative advantage are encouraged. In line with this thinking, the integrated research approach provides incentives for the promotion of new technologies and the framework necessary for their effective implementation. Scientific institutions are also encouraged through public sector funding to play an active role in the targeted areas, which include ecological research, research in the field of environmental technology and environmental education. Priority is given to the promotion of environmentally sound technologies that allow a cleaner production process. For industrial sectors, priority is given to technological efforts that lead to a sound management of materials inputs and outputs. The importance of integrating management, planning, innovation and environmental protection features in the production process is recognized.

29. In the United Kingdom, several government ministries are responsible for promoting the development and diffusion of environmentally sound practices and technologies. The Department of the Environment, Transport and Regions, for example, carries out programmes for energy efficiency and environmental technology best practice. These programmes aim at stimulating the adoption of cost-effective technologies which have environmental benefits through industry's reduced use of raw materials and lower waste disposal costs.

30. In the Republic of Korea, a noticeable increase in government funding for clean technology development is observed. The country case study shows that almost every basic clean technology project within each of four major categories -- product, process, treatment and recycling -- was primarily supported by government funding, even though traditionally R&D had mainly been privately funded.

[22] OECD, *Technologies for Cleaner Production*, Paris, 1995, p. 70.

31. In Japan, among the institutions specifically geared to environment-related research is the New Energy and Industrial Technology Development Organization (NEDO). NEDO was established immediately following the second oil crisis as a core government institution for technological development. Similarly, the Research Institute of Innovative Technology for the Earth (RITE) was established in 1990 in order to support "innovative environmental technology development in response to global warming". At present, there are 16 national R&D institutes focusing on environmental technologies alone. Local public institutes are also active in this respect.

III. PATTERNS AND MODALITIES FOR THE TRANSFER AND COMMERCIALIZATION OF ESTs

32. How are ESTs diffused and/or commercialized and what mechanisms exist to facilitate the transfer of such technologies to third countries? This chapter describes established patterns of transfer of publicly funded R&D in the area of ESTs, including those related to existing Multilateral Environmental Agreements (MEAs). It takes stock of a variety of models that exist nationally and internationally.[23] It does so in an illustrative manner, as the scope of this study does not allow an exhaustive coverage of bilateral and multilateral initiatives.

33. Some developing countries continue to face difficulties in accessing foreign technology, including ESTs. However, technology transfer is a complex process that cannot only be defined in terms of access to technology (the supply side), but needs to be examined in terms of the demand side as well. On the demand side, for example, the small size of most firms in developing countries as well as the lack of support structures are impediments to obtaining technology. These issues are often neglected if discussions of policies for promoting the transfer and diffusion of ESTs focus primarily on the supply side.

34. The above considerations led to a number of questions. What are the modalities, if any, relating to the transfer and commercialization of publicly funded ESTs including relevant policies, institutional arrangements and aspects, and existing regulatory regimes relating to the protection, exploitation and diffusion of these technologies? Could governments influence this process? What are the implications of public-sector involvement in the financing of R&D for the ownership, transfer and commercialization of these technologies?

35. ESTs are different from other technologies, such as the new information and communication technologies, for a number of reasons: (i) compared with other areas, the stakes are higher in ESTs given the urgent nature of global environmental degradation and the degree of international commitment reflected in existing multilateral environmental agreements. In this context, it has been argued that the state of the global environment is sensitive for the national well-being of nations and that "environmental security" will become an increasing concern in the coming years; (ii) the framework for the introduction of ESTs is highly regulatory, ranging from areas such as wastewater treatment to CFC substitution; (iii) many governments have been funding R&D for the development of ESTs required to meet specific needs, including environmental regulations; (iv) unlike other technological areas, very often the development of ESTs necessitates public "seed" funds as incentives for companies to initiate EST-related R&D. Firms by themselves are often reluctant to develop ESTs if they are considered expensive and if the return is difficult to foresee (for example, if regulations and standards are vague); (v) many ESTs are commercialized by specialized small and medium-sized firms (SMEs). Often such firms must rely on support structures to develop markets, both domestically and in other countries. Unlike in other technological areas, few venture capital firms see a market in ESTs to provide the initial support needed; (vi) many ESTs are developed and receive public R&D funding with very specific domestic applications and markets in mind and are thus not automatically suited to other markets, particularly the specific conditions and needs prevailing in many developing countries. For the above reasons, it is assumed that ESTs could -- theoretically -- be treated differently from other technologies in terms of the modalities of their transfer and diffusion.

Issues and policies

[23] Chapter V will elaborate on the possibility of alternative transfer and diffusion mechanisms that could offer new opportunities for an accelerated use of ESTs throughout the world, including the developing countries.

36. In most countries analysed in this study, government policies and regulations play a role in the development, transfer and diffusion of ESTs. They stimulate innovation in ESTs through regulatory policies that set environmental standards in areas such as waste, water and emissions. For example, the Clean Air Act in the United States required 22 major metropolitan areas to improve their air quality or lose federal funds. This has led to considerable research activity in finding less-polluting transportation technologies.[24] A number of ESTs have been developed by traditional industries to meet regulatory needs.[25] In some countries, policies creating such demand are explicitly stated and consistent; in others, particularly the developing countries, a clear policy framework could not be identified.

37. All countries included in this study have established institutions dealing with the promotion of ESTs and different models of R&D community-enterprise cooperation without directly interfering in the transfer and commercialization process. Some governments have also introduced incentive schemes designed to facilitate or accelerate the development and application of ESTs. These include tax incentives, preferential loans, financial grants or similar measures designed to support private sector use of ESTs.

38. Some governments exercise a strong level of control over the selection of R&D projects and programmes to be funded, and -- increasingly -- this decision is made in favour of funding EST-related R&D. However, in most countries government involvement does not extend to the commercialization and transfer of these technologies.

39. Nevertheless, other governments do exercise a degree of control over technologies developed with government R&D funding, at least for a limited period of time. In the Republic of Korea, for example, institutions which receive public funds for R&D programmes own the intellectual property rights of the technologies developed. These could be national/public research institutes (NRIs), government-invested institutions (GIIs) or government-supported research institutes (GRIs), universities, research associations and other legal entities. Cooperative R&D programmes involving private companies and GRIs or universities are common. Since the 1970s, the Government has adopted various policy measures to promote such cooperation and such efforts receive top priority for research grants. Some of the technologies developed under public programmes are owned by these research institutes. The Republic of Korea study concludes that, as a consequence, some direct or indirect government influence does exist. This applies also to R&D related to clean production technologies developed under such programmes, which often fall into the category of "publicly owned technology".

40. A common trend in the transfer and commercialization of ESTs reflected by several case studies is to be found in collaborative efforts sought through networks, partnerships and alliances. Increasingly, the "research culture" and the "business culture", each of which are different,[26] join forces in the "demonstration" and "prototyping" of new technologies. Several countries refer to the importance of such

[24] W. W. Clark and E. Paolucci, "An industrial model for technology commercialization: Fuel cells into design manufacturing", paper delivered at the International Conference on Product Design and Manufacturing, Stockholm, May 1997.

[25] Lanjouw and Mody (1996), for example show that the level of innovation in ESTs as measured by patenting in the areas of air and water pollution is responsive to regulatory policies at home, but also abroad. The latter operates in particular when trade relations are involved. Air pollution limitation in Germany thus increased in response to car emission standards in the United States (J.O. Langjouw and A. Mody, "Innovation and the international diffusion of environmentally responsive technology", in *Research Policy*, vol. 25, no. 4, 1996, pp .549-572).

[26] They operate under different rules and norms. For the researcher, publications are a pathway to advancement; while this has been changing in some technological areas, it is still the basic cultural norm in most public R&D institutions. For the business culture, getting technologies commercialized and into the market-place is the incentive and basic driving force. This is a generalization, however. As demonstrated by some of the case studies, there is already a degree of integration of the two cultures in some countries or academic fields.

public-private partnerships involving a broad range of economic actors ranging from universities and R&D institutions to government entities and private companies. While most such initiatives are designed for technology transfer and commercialization at the national level, a limited number of initiatives have been taken to develop similar schemes for cooperation internationally, including developing countries.

41. Many governments are conscious of the international dimension of global environmental degradation and the role of ESTs in addressing this problem. This continues to be a major challenge facing the international community. A recent OECD study concluded that:

> "Given that non-Member countries are predicted to triple their industrial output by the year 2010 as compared to 1990, *direct application of cleaner production technologies outside the OECD area will be crucial for sustainable development.* The OECD and its Member countries must therefore give attention to technology and information transfer."[27]

Accordingly, several industrialized countries are now developing schemes under their official development assistance (ODA) to facilitate the transfer of ESTs to developing countries, and some have earmarked a proportion of their ODA for environment- and EST-related projects (Germany, Japan and the United Kingdom, for example).

42. Canada promotes the transfer of ESTs through bilateral agreements. It has signed a host of Memoranda of Understanding on Environment Cooperation with other countries. While these agreements are general in nature, they facilitate specific projects, some of which involve technology transfer. For example, one such arrangement is the letter of intent with respect to the joint project known as "Watershed Management 2000 -- Improvement of Water Resources Management in the State of Sao Paulo". This project involves a partnership between a large number of Canadian and Brazilian institutions. While some of the start-up funding originates in Canadian ODA (Canadian International Development Agency (CIDA)) as well as "in-kind" contributions by participating organizations, it is anticipated that a successful start of the project will also attract other international donors with interests in Brazil (World Bank, Inter-American Development Bank). The project involves a broad range of support measures to improve water management and treatment in the State of São Paulo.[28]

43. A number of the country studies describe institutions, bilateral cooperation agencies and non-governmental organizations which have initiated similar programmes. Many of these new initiatives aim to increase North-South technology partnerships through the encouragement of joint ventures, licensing, joint technology development and the creation of information clearing-houses and "match-making" services, needed to make both suppliers and potential technology recipients aware of opportunities in the area of ESTs. Public support, including funding, is often a factor in the development of these initiatives.

44. Japan has developed an initiative for mitigating global warming -- the Green Initiative. Its objective is to promote and accelerate the introduction and dissemination of technologies for energy saving and non-fossil fuel energy technologies in developing countries. Under this initiative, various programmes for technology transfer and financial assistance have been implemented or are in the planning stage. Similarly, the Green Aid Plan was developed in 1992 "in order to promote the transfer and dissemination of Japanese technology and experience to developing countries of Asia".[29] The programme concentrates on efficient energy utilization and prevention of industrial pollution.

---

[27] OECD (1995), p. 12.

[28] See the Canadian country study and the Canadian International Development Agency, *Watershed Management 2000 in the State of São Paulo, Brazil*.

[29] OECD, *Climate Technology Initiative: Inventory of Activities,* Paris, 1996, p. 26.

45. The United States provides technical advice and facilitates access to private financing. The Country Studies Program Support for National Action Plans assists developing countries and countries with economies in transition in carrying out technology assessment as a basis for developing national climate action plans.[30] However, two important mechanisms for the dissemination of ESTs by the United States to other countries (including developing nations) are also the Export-Import Bank and the Overseas Private Investment Corporation. The former provides companies with funds (e.g. credit, loans, guarantees) for the goods and services of a company that seeks to export. The Bank will target certain regions of the world and therefore give preferential rates and service to companies seeking business there.

46. Another example of a bilateral programme is the United States-Asia Environmental Partnership Initiative (USAEP). Under this programme joint study groups were formed involving universities and national laboratories from both regions with a view to facilitating the transfer of advanced environmental and energy technologies through private sector cooperation. The initiative includes face-to-face interaction between the different partner institutions as well as on-site environmental assessments and training programmes.

47. In Germany, the Federal Government promotes the building of scientific and technological capabilities of developing countries, including in the area of ESTs. Related projects, which have specific research objectives, complement the development schemes of the Federal Ministry for Economic Cooperation, which support, among other things, the development and improvement of the scientific and technological infrastructure (higher education, technology centres, research institutes) in the developing countries. Environment-related funding and support focus mainly on energy research and energy technology, and the study of tropical ecosystems. Generally, cooperation in the field of environmental technologies concentrates on developing and adapting low-emission technologies for use in developing countries. Important activities are the development of ecologically sound manufacturing processes, sewage and waste treatment, as well as studies of soil and air pollution.

48. One example of public-private cooperation at the international level is the Technology Partnership Initiative (TPI) of the Department of Trade and Industry in the United Kingdom. The TPI was established to promote technology cooperation in the area of ESTs between British and developing country firms. Its main aim is to promote direct access by businesses from developing countries and newly industrializing economies to information on environmentally sound technologies available in the United Kingdom. It has established several criteria for ESTs: they have to be affordable; they have to be appropriate to the needs of a wide range of industrializing developing countries; and they have to enable businesses operating in developing countries to grow in accordance with sustainable development principles. The main mechanisms of the TPI are to expand existing channels of communication between United Kingdom businesses and those in developing countries; to provide information about the opportunities for joint ventures and other forms of partnership; to make available to businesses in developing countries case studies and guides to best practice; and to provide information on technological solutions and techniques and demonstration of leading-edge technology. The Initiative also covers environmental management and training and sources of finance. It has sponsored seminars and supported the work of international organizations (UNEP, UNCTAD) in these areas. Furthermore, it identifies United Kingdom companies prepared to part-finance training.[31]

49. There are a limited number of other pilot projects, mechanisms and programmes addressing issues such as financing of the various phases of technology transfer, creating awareness, finding partners, launching specific transfer processes and encouraging R&D institutions to transfer technology. Some of these are in the area of ESTs, while others address technologies in a more general way. However, all of them could

---

30 *Ibid*., p. 29.

31 Department of Trade and Industry, Technology Partnership, *Guide to UK Environmental Technology and Services*, London, 1993; Stella Blacklaws, "Environmental technology cooperation", in UNCTAD, *Technological Capacity-building and Technology Partnership*", Geneva and New York, 1995.

serve as effective models for the transfer and diffusion of ESTs. For example, the United States Agency for International Development (USAID) supported a five-year University-Industry Linkages and Economic Development Program. This project was designed to ensure collaboration between Northwestern University in the United States and the Autonomous University of Yucatan in Mexico, focusing on linkages between the university and the local productive sector. Its objectives were to develop joint research capabilities as well as an academic programme in technology and organizational performance, and to extend extension programmes of the Mexican university to assist local manufacturers.[32]

50. Similarly, aYale University initiative, in collaboration with UNDP, supports the creation of public-private partnerships to tackle water, sewage and energy problems in urban environments. The project emphasizes eco-efficiency, stakeholder participation and replicability. It uses ODA to leverage private sector investments by creating joint ventures while building an effective enabling environment with solid supporting mechanisms at the same time.[33]

Multilateral initiatives

51. At the multilateral level, several initiatives are under way as well. Thus, the OECD and the International Energy Agency (IEA) are engaged as facilitators for technology transfer in various ways. One such example is the Climate Technology Initiative (CTI). CTI was launched in 1995 as a voluntary initiative by 23 OECD/IEA member countries and the European Commission to support the technology-related objectives of the Framework Convention on Climate Change. It generally aims at developing and disseminating climate-friendly technologies. In that context, joint research agreements involving scientists from a dozen nations have been signed under this initiative. At the same time, partnership agreements with five major international organizations have been concluded. The IEA provides the technical and staff support. Activities have included regional workshops in developing countries, and analysis of information centres and networks to support the climate change negotiation process.[34]

52. Another example of international cooperation is the IEA collaborative effort in the area of energy technology R&D. Each project is set up under an "Implementing Agreement", which provides a legal contractual mechanism. Within this framework, participating countries choose the particular tasks in which they wish to be involved. There are currently over 40 active IEA Implementing Agreements. Research expenditures are directly coordinated through the programme. Countries achieve a multiplier effect on their contribution, gaining access to results generated by all the partners. Implementing Agreements provide substantial leveraging of domestic expenditure through, among other factors, sharing costs, pooling resources, strengthening national R&D capacities and building a common understanding of the technical basis of issues.[35] International cooperation may include non-member countries. According to the OECD, IEA collaborative activities have been at the forefront of research to solve environmental issues related to energy technologies. In this context, new collaborative activities in the area of the environment have been initiated,

[32] Atul Wad, "University-industry linkages and economic development: Lessons and analytical perspectives drawn from the UDLP project", paper prepared for the VIth Symposium on Technology Management, Autonomous University of Yucatan, Merida, 4-5 December 1997.

[33] Environmental Health and Safety Management, Inc., *EHS Management*, 27 October 1997.

[34] CTI, Press Release, "UNEP joins forces with Climate Technology Initiative to combat climate change", Kyoto, 4 December 1997. See also OECD, *Climate Technology Initiative,* Paris, 1996.

[35] See, for example, IEA, *International Energy Technology Collaboration: Benefits and Achievements*, Paris, 1996 (OECD publication), pp. 15-17.

such as "GREENTIE" and "CADDET Renewables", which are promoting the increased utilization of new environmentally benign technologies to reduce greenhouse gas and other emissions.[36]

53. In addition to the agencies that have prepared the present document -- UNCTAD, DESA and UNEP -- several international organizations carry out work relevant to ESTs within their specific mandate. Often these include information, advisory services or "match-making" activities. For example, UNIDO, in cooperation with UNEP, has launched a programme for National Cleaner Production centres conducting in-plant demonstrations, providing training for cleaner-production assessors, disseminating information and giving policy advice. Specialized programmes including technology transfer exist in particularly polluting sectors such as the tanning industry.

54. The European Union (EU) provides public support for moving R&D, even in the private sector, from knowledge generator to potential users. It recognizes that SMEs often require financial assistance to turn research results into marketable products. One type of financial assistance is equity capital, and the First Action Plan for Innovation in Europe (1996) attempts to deal with a number of barriers to the commercialization of research identified by the Commission, notably the high costs of initial appraisal and the need for ongoing management and support. When the venture capital market is not very well developed, these factors create additional difficulties for SMEs. An Innovation and Technology Equity Capital "pilot scheme was launched in July [1997] ... to lower these barriers by directly supporting the development of cost-effective appraisal and management procedures".[37] In addition, the EU has developed other programmes to move "publicly" funded R&D, e.g. R&D supported by one of the EU's "RTD" projects, to users; one is a programme to validate R&D results by setting up pilot projects as part of a transfer of technology process. The programme, an extension of the SPRINT specific projects, is part of the EU's Innovation Programme and is aimed at transferring generic technologies from one sector to another and encouraging the diffusion of such technologies across EU regions. It also seeks to foster links between the enterprise sector and research institutions. While the above initiatives focus on EU countries and firms, the EU has acknowledged that EU research policy must also take into consideration the needs of developing countries. The current EU research programme has allocated funds for cooperation with developing countries and for a regular exchange of knowledge between the EU and developing countries.

55. In 1984, an international research cooperation network in the area of science and technology -- CYTED -- was created, linking 21 Spanish- and Portuguese-speaking countries from Europe and Latin America. This programme, which is supported by several international organizations, involves different models of cooperation between universities, R&D centres and enterprises. Its primary objective today is to establish cooperation in research and technology development and the transfer of R&D results to the productive sector. It includes sectoral activities relevant to ESTs in areas such as energy conservation and biodiversity.[38]

56. All major international agreements addressing global environmental problems, ranging from the Convention on Biological Diversity to the United Nations Framework Convention on Climate Change, and -- in particular -- the Montreal Protocol and its amendments, contain specific provisions regarding legislative, administrative or policy measures for access to and transfer of technology. However, in reviewing initiatives to implement these provisions, a general observation can be made that the use or development of appropriate modalities/mechanisms to facilitate the transfer and diffusion of ESTs has not been at the forefront of the policy deliberations under these agreements. The general focus is on "information", in particular the identification of technologies that are considered essential to the further implementation of

[36] *Ibid*., p. 20.

[37] "Capital for exploiting research results", in *Innovation and Technology Transfer*,vol. 4, July 1997 (EU Commission).

[38] *Noticias de CYTED*, Programa Iberoamericano de Ciencia y Tecnología para el Desarollo, Numero 9, June 1997.

the conventions, accessibility to information on these technologies as well as the modalities for the dissemination of this information. Concern about R&D basically related to the adaptability of available technologies to the specific needs of countries rather than research on, and development of, new technologies.[39]

57. For example, a significant part of the technology-related recommendations adopted by the Basel Convention centred on the establishment and networking of regional and/or subregional centres for training and technology transfer. Progress being achieved in establishing regional and subregional centres for training and technology transfer, and on organizational arrangements and the funding situation regarding the respective centres, will be reported to the Conference of the Parties.

58. The Conference of the Parties of the Biodiversity Convention centred its discussion on the usefulness and modalities of establishing clearing-house mechanisms to promote information exchange on scientific and technical matters, policy and management issues, technology transfer and capacity-building.

59. The Convention to Combat Desertification called for the development of new technologies to stop desertification or cope with its effects. Those technologies should be transferred to countries in need of them and adapted to local circumstances. In various contexts, the Convention calls for scientific and technical cooperation among the Parties to it in areas such as joint research programmes, information collection and dissemination, technology transfer, protection and utilization of traditional and local knowledge and know-how, conservation of land and water resources, and sustainable management of transboundary natural resources. Scientists world-wide are encouraged to contribute with their know-how and research results to this effort.

60. Under the Framework Convention on Climate Change, surveys are being conducted on technology transfer activities of member countries, as well as on the terms of transfer of technologies that are available and relevant to the implementation of the objectives of the Convention. Priority is given to methods for monitoring and assessing the effectiveness of policies and implementation strategies to support the use, adaptation and diffusion of technologies. The Global Environment Facility (GEF) provides for interim funding for specific well-defined projects.

61. Under the Montreal Protocol, the "OzonAction Programme" was established as an information clearing-house in response to the realization that: (i) there is a clear need for technology transfer to comply with a legally binding international agreement; (ii) there are efforts to develop national strategies through country programmes; (iii) there is an extensive effort to obtain and disseminate, on a wide scale, information on the available technical options and sources of technologies, equipment and chemicals; (iv) there are extensive training and networking efforts to build local capacities for ODS phase-out; and (v) there is financial support for the entire effort. A specific feature of the Montreal Protocol is the creation of a multilateral fund specifically intended to accelerate the use of alternative technologies to CFC gases in developing countries. The establishment of this specifically focused fund has been widely regarded as a success, although there are a number of shortcomings.

Impediments to technology transfer and diffusion

62. As shown in this report, a broad range of ESTs are generated from publicly funded R&D activities that could meet the needs of developing countries and economies in transition. In many respects, the needs of developing countries, in terms of global environmental protection, are not different from those of developed countries. However, there are differences in the capacity and capabilities of countries to apply available ESTs effectively. The constraints that firms face in accessing ESTs available in both developed and

[39] The Montreal Protocol may be an exception.

developing economies originate from both supply and demand sides. Among the supply-side obstacles noted in the case studies are the protection or lack of appropriate protection of intellectual property (as discussed in chapter IV), cost factors (too expensive), lack of relevant information to make the right choice, the fact that some ESTs are not yet marketable or marketed, time-consuming licensing procedures adding to the cost of the technology, and inadequate policy and incentive measures in technology-producing countries to promote the diffusion of ESTs. Some ESTs are costly, especially for small firms in developing countries. This is partly because the technologies may be in their infancy or the main focus of the entities generating the technology may be on research rather than the economic viability and commercialization of the technologies generated.

63. On the demand side, some of the major impediments include financial constraints, lack of local capacity and the skills required to acquire, adapt and assimilate technologies, lack of awareness and relevant information on available ESTs, and the absence of regulations, policies, incentives and the instruments of enforcement to advance the utilization of ESTs. Firms, especially those in developing countries, are not often aware of the range and types of ESTs available and the benefits, in terms of efficient use of raw materials, clean-ups and competitiveness, arising from the application of such technologies. In developed countries, the formulation of explicit policies and the introduction of incentive measures specifically designed to influence both producers and consumers to use ESTs were instrumental in promoting their use. It is evident that the effective diffusion of ESTs is dependent on the local policy and regulatory environment conducive to wider use of such technologies.

64. The issue of affordability is often a major demand constraint, particularly where the economic conditions of the country to which the technology is to be transferred are very different from those of the industrialized country where the technology has been developed and applied. For example, the size of the market and the less sophisticated distribution systems and marketing channels may mean that production costs per unit will be higher and a high volume of production cannot be attained. The technology as applied in industrialized countries may well need to be adapted to these different conditions, which will also incur additional costs. Overcoming the initial barriers to the introduction of a new technology may require public sector funding, as deliberate efforts are required in constructing an economic and policy environment appropriate for the transfer and diffusion of ESTs and to sensitize potential users to the advantages of acquiring, adopting and assimilating ESTs. Yet these are not always present, as the case studies show.

65. Some country studies explicitly list impediments to the transfer and commercialization of ESTs at the national level.[40] A German survey of private and public enterprises and public institutions found that new products are too costly; the technologies generated are not readily marketable; there is a lack of awareness on the part of potential users; and the procedure for obtaining licences takes too long, thus adding to the cost.

66. Often, specific policies for the transfer and diffusion of ESTs do not exist. For example, the country case study for Brazil found that "no discernible patterns for the diffusion of ESTs were identified in the survey". A similar observation was made by the special study on the MERCOSUR countries. The report of the Czech Republic concluded that

> "the overall regulatory regime is rather underdeveloped. The protection and exploitation of the results of R&D are subject to an internationally established legal framework that is in place.... However, there are no special instruments in place to stimulate the dissemination of results, the development of prototypes and/or the commercialization of the technological innovation."

[40] See also chapter IV for specific legal and institutional impediments.

In contrast, United States legislation, such as the Stevenson-Wydler Technology Innovation Act of 1980, is explicit in its intention of ensuring that publicly funded R&D is put to "commercial and useful purpose." However, the Bayh-Dole Act, also enacted in 1980, makes it clear that the primary aim of publicly funded R&D is "to promote the commercialization of public availability of inventions made in the United States by United States industry and labour".[41]

67. A difficulty in commercializing publicly funded ESTs on a global level due to legal constraints is exemplified by a case study of fuel cells in the United States.[42] Publicly funded research in the area of fuel cells, as an environmentally friendly technology for automobiles, did not initially find a private firm ready to commercialize this technology, which had been developed in a national laboratory. Eventually, an international financial and manufacturing consortium led by Australian investors entered into a Cooperative and Development Agreement with the laboratory. However, policies governing publicly funded R&D requiring "substantial manufacturing" in the United States proved to be an impediment to the transfer of technology. The technology was finally commercialized through the creation of an international consortium which involved an American firm.

68. As pointed out above, there are "cultural" gaps between the research communities and the private sector which partly explain the small proportion of R&D results that are transferred to the productive sector or commercialized.[43] More often than not, the incentives for the private sector to commercialize R&D results (market penetration, profit and equity) are different from those that motivate the public sector R&D institutions (publications, promotion and tenure). For instance, despite years of collaborative links between university researchers and industry promoted through EU programmes such as ESPRIT, interviews with both business and researchers show wide gaps in the work cultures and in the expectations they have of each other. [44]

IV. POLICY AND INSTITUTIONAL FRAMEWORK

69. The dominance of liberal approaches to economic management has entailed a shift in the choice of mechanisms to encourage the process of technology transfer. Increasingly, the private sector has been placed at the centre of the technology transfer process in contrast to a state-oriented approach. This new trend does not preclude public authorities from assuming a role to influence the transfer of publicly funded technologies, and the existing legal regimes, with necessary variations, still include a number of public policy instruments that in the context of sustainable development imperatives deserve further consideration.

70. This chapter discusses policy, institutional and legal issues relevant to the transfer of ESTs derived from publicly funded R&D activities. It describes selected policies and mechanisms for the diffusion and commercialization of R&D results, with emphasis on intellectual property rights regimes, including institutional mechanisms in public entities. It draws on surveys undertaken in the United States, the MERCOSUR countries (Argentina, Brazil, Paraguay and Uruguay) and France. The French study also considered related policy measures of the European Union. The key findings and conclusions of these studies are summarized below.

---

41 For details of this legislation, see chapter IV.

42 Clark and Paolucci, *op. cit.*

43 Compare explanation in chapter III above.

44 See B. Vavakova, "Building 'research-industry' partnerships through European R&D programs", *International Journal of Technology Management*, vol. 10, nos.4/5/6, 1995 (Special Issue on the Evaluation of Research and Innovation), pp. 567-586.

Main findings of the surveys

71. The legal survey undertaken in the United States shows that, for at least the past two decades, the goals of policies have been to promote commercial development of federally sponsored technologies and to leverage research funding into areas where United States products have a strong comparative advantage in world markets. These goals pervade not only general statutory provisions applicable to technology transfer across the spectrum of federally sponsored research, but also more specific statutes concerning environmental technologies. The policy of the United States has strongly favoured private appropriation of the results of publicly sponsored research through primarily the patent system. Two principal strategic motivations emerge from a review of legislative provisions governing the commercialization of government sponsored research. The first is a desire to motivate the private sector to pick up where government funding leaves off, so that research advances can be developed into useful new technologies;[45] and the second is the improvement of the competitive position of United States firms.[46]

72. Under existing law, federal agencies sponsoring research in United States-based institutions are directed to permit the latter to retain patent ownership, provided that these institutions are diligent about pursuing commercial development of the inventions either on their own or through licensees. In cases where the sponsoring agency retains ownership, the agency is directed to make technology transfer to the firm level a priority and is permitted to grant exclusive licences to private firms in order to promote commercial development. Regardless of who owns the patent rights, preference in the selection of exclusive licensees is to be given to firms that agree to manufacture substantially in the United States. Sponsoring agencies retain "a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States any subject invention throughout the world".

73. In France, there is no specific legal regulation on the commercialization of ESTs, with the exception of general provisions in Law No. 95-101 of 2 February 1995, relating to the reinforcement of the protection of the environment, which introduced some new principles to French law, and the regulations protecting the environment in general, which limit or prohibit the use of certain technologies. Nor does the French system provide for specific policies concerning the commercialization of publicly sponsored R&D. Nevertheless, it is worth noting that, in the French system, publicly funded research falls under two broad categories. The first relates to research conducted directly by a public entity (state services, state body or local community), in which case the results are the property of that public entity; and the second relates to research conducted by private entities, acting on behalf of or with the financial support of a public entity. These categories apply to all R&D activities, including those related to ESTs.

---

[45] With respect to this first strategic motivation, the findings set forth at the beginning of the Stevenson-Wydler Technology Innovation Act of 1980 make this explicit: "Many new discoveries and advances in science occur in universities and Federal laboratories, while the application of this new knowledge to commercial and useful public purposes depends largely upon actions by business and labor. Cooperation among academia, Federal laboratories, labor, and industry, in such forms as technology transfer, personnel exchange, joint research projects, and others, should be renewed, expanded, and strengthened". The Bayh-Dole Act, also of 1980 -- aimed at encouraging small businesses and non-profit organizations to patent the results of government-sponsored research -- states that "It is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally supported research or development".

[46] According to the Bayh-Dole Act, a targeted aim is "to promote the commercialization and public availability of inventions made in the United States by United States industry and labor". The Stevenson-Wydler Act's introductory list of Congressional findings deplores that "[i]ndustrial and technological innovation in the United States may be lagging when compared to historical patterns and other industrialized nations" and claims that technology and industrial innovation facilitate "creation of new industries and employment opportunities and enhanced competitiveness of United States products in world markets" and will "reduce trade deficits, stabilize the dollar, increase productivity gains, increase employment, and stabilize prices".

74. Since the mid-1980s, an important shift in the paradigm of publicly funded R&D has taken place in the MERCOSUR countries. Increasingly, public sector R&D institutions are encouraged to recover R&D costs through the appropriation and transfer to the productive sector of the results of their R&D activities. However, as in the case of France, the appropriation and transfer of the results of publicly funded R&D are not subject to a specific regime, but to general rules originating in different legal regimes, namely constitutional and civil law, intellectual property, contract, labour and administrative law. These regimes, as applied at the national level in each country, determine the general conditions for the appropriation and transfer of publicly funded R&D results. The current trend in public R&D institutions in the MERCOSUR countries is not simply to place R&D results in the public domain but, if possible, to claim intellectual property rights and demand compensation for their transfer.

Policy and institutional issues

75. The surveys of the regulatory and legal regimes governing technology transfer in the area of ESTs in the United States, France/EU and MERCOSUR countries have raised policy and institutional issues that include a broad range of questions relating to foreign access to technology, intellectual property rights and licensing. In this context, it was noted that the legal and institutional framework of ESTs did not differ from technology in general and that ESTs are subject to the same rules governing all results of publicly sponsored R&D. The United States is one country that has paid more attention to specific policies governing the results of R&D in general. In the case of the other countries reviewed in the project, general principles of law, either of a public or private nature, regulate the matter.

76. One issue raised by the study was that of the availability of ESTs that are publicly owned. The concept of "publicly owned" technology is distinctively different from that of "public domain".[47] The latter means that the knowledge is freely accessible and usable, i.e. anybody can use it without authorization and compensation. In contrast, the concept of "publicly owned" technology indicates that there exists some form of appropriation based on the intellectual property rights (IPRs) held by the public entity. Because of the high cost of obtaining patents throughout the world, however, it may be that many ESTs that are covered by patents will remain unpatented in developing countries. In cases where there are no local patent rights covering the technology, it may be possible to obtain the necessary technical information from publications, foreign patent documents or government agencies, and put it directly to use.

77. But even when patent rights do not compel developing countries to go through foreign firms to obtain access to ESTs, there may sometimes be technical advantages to collaborating with firms that have developed ESTs commercially and have extensive experience with these technologies. In other words, neither public domain nor "public ownership" is equivalent to immediate mastering of the respective technology. The economic agent needs the technological capacity to exercise those rights. This issue of technology, theoretically placed in the public domain, deserves further exploration, particularly in the context of publicly funded R&D. Here it is important to stress that there are situations in which it might be in the common interest of an R&D institution and of an economic agent to enjoy exclusivity in the use of a technology developed by the former that has not been protected in a particular country. The lack of intellectual property rights protection could be, in this particular case, an obstacle to the utilization of ESTs. In this instance, a case could be made for considering the conferring of a special status on the transfer of ESTs in order to protect the investment and the technology that otherwise would not enjoy protection under traditional intellectual property rights regimes.

78. As noted above, in a framework of increasing "privatization" of public research, "publicly funded R&D" does not generally mean that the results of the R&D are "publicly available", but that the results could be subject to appropriation under patents or other titles held by the entities that took part in their

[47] See footnote 12.

development. There is, however, a qualitative difference between technologies fully subject to private decisions and those that may not be exclusively subject to private decisions, the topic of this study. It has been observed that the public entity can still exercise some influence concerning the use and commercialization of publicly funded technology. For example, in the case of the United States, which has undoubtedly a highly elaborate legal regime on the subject, the Government retains rights to grant licences on reasonable terms if (a) the contractor fails to take effective steps to achieve practical application of the invention; (b) such action is necessary to alleviate health or safety needs; (c) such action is necessary to meet requirements for public use specified by federal regulations; or (d) the contractor or its exclusive licensee has either failed to agree to manufacture substantially in the United States or is in breach of such an agreement.[48]

79. Furthermore, in the United States, some statutes (including the Clean Water Act and the Atomic Energy Act) provide for the issuance of mandatory licences in cases where firms controlling the patent rights are not willing to license certain technologies on reasonable terms. The statutory provisions and implementing regulations make clear, however, that mandatory licences are a remedy of last resort available only to parties that have been unable after reasonable efforts to obtain a licence from the owner of the patent on reasonable terms. Even these limited provisions for mandatory licences are extraordinary in the United States patent system, which as a general rule entrusts patent licensing to the realm of private bargaining. It could not be verified, however whether any such licences have ever been granted.

80. In the other countries under examination, intellectual property rights held by public entities are generally deemed a "private" property of the State or of the parastatal institution, and they can therefore be assigned or licensed through contractual arrangements to third parties. In general, there are no restrictions on granting exclusive licences, or even assigning them to a contracting party that has financed or co-financed the respective research project. The appropriation of the technology is subject to the general regime governing intellectual property rights, and in this context, compulsory licences are provided in line with the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).

81. It was observed in several case studies that, in the generation and commercialization of ESTs, there is a trend towards partnerships or consortia in both the public and private sectors as well as between the public and private sectors. The following paragraphs describe some existing mechanisms in public institutions in the developed and the developing countries that could become important vehicles for partnerships or consortia to facilitate the transfer and commercialization of ESTs.

82. Universities play an important role in developing programmes for the commercialization of technology that are generated through publicly funded research. For example, four private American universities reviewed in this project -- Columbia, Harvard, Yale and Stanford -- were found to have special mechanisms for the commercialization of technologies. These universities are renowned for active collaboration between government and academia in specialized fields relevant for the generation of ESTs. The four universities have Offices of Technology Transfer and Licensing established during the 1980s. Each has the role of protecting the intellectual property rights developed by their respective researchers and the economic interests of the university, on the basis of the federal laws governing publicly funded R&D. Each institution is allowed to determine how royalty fees, royalty sharing and other compensation are allocated. For example, Harvard operates its royalty-sharing policy in its Office of Technology and Trademark Licensing through a distributed allocation to the inventor (researcher), the researcher's department, the faculty and the university in general. The main federal legislation that guides university policies in the area of publicly funded R&D is the Bayh-Dole Act of 1980. In this respect, the guidelines on university technology transfer developed by the Council on Governmental Relations (COGR) provide that "Universities should be extremely cautious in considering foreign licensees, especially if the research was funded by the United States Government. For

[48] 35 U.S.C.A. § 203(1).

those inventions, all exclusive licenses require the licensee, including foreign companies, to manufacture products substantially in the United States".

83. In the case of the MERCOSUR countries, many institutions that undertake and/or fund R&D have also established their own policies and regulations on the appropriation and transfer of publicly funded R&D results. However, there is no general regime applicable, and, therefore, a high degree of decentralization exists. In order to define the legal status of a particular set of results of publicly funded R&D, it will be necessary to determine the extent to which the general legal regimes and/or specific institutional regulations are applicable. The policies adopted by public institutions involved in R&D activities generally define the allocation of rights between the institution and the research personnel, or between them and a third party that has contracted the research. Normally, the transfer of R&D results to third parties is promoted without discrimination in terms of nationality, capital, size or other characteristics of the receiving companies.

84. In practice, however, the number of patents actually applied for by universities and other R&D institutions, though growing, is very small. In the case of Brazil, the issue of intellectual property rights is quite new for universities. Each university defines its own policy for the appropriation and transfer of R&D results. The general approach is that such results are controlled by the universities themselves. When they are exploited through a licence by a third party, the researchers may generally claim a participation in the benefits. In the case of Brazil, between 1988 and 1991, universities and R&D institutions applied for 222 patents, less than 1 per cent of patent applications made by residents of Brazil. The productivity of such institutions in terms of patents per researcher has been extremely low (less than one a year), with some exceptions.[49]

ESTs and the TRIPS Agreement

85. The prevailing paradigm, which favours the private appropriation of technologies resulting from publicly funded R&D, relates to the role of intellectual property rights in the transfer of those technologies. This points to the new features of IPRs. As highlighted in a recent study by UNCTAD, attitudes towards intangible property are actually evolving.[50] There appears to be an emerging global consensus that unauthorized copying of copyrighted material (software, music, films, etc.) and trademark products (clothing, cosmetics and jewellery) for purposes of resale is an illegitimate activity and should be eliminated. Attitudes towards creation, dissemination and ownership of technological information (for example, production processes for pharmaceuticals, biotechnological products) remain more divided. Against this new background, and in the light of a backdrop of growing concern over differences and inadequacies in IPRs systems and of the difficulties this situation posed for global exploitation of intellectual assets, countries committed themselves, in the Uruguay Round, to adopting a set of universal standards of protection. The Final Act, embodying the results of the Uruguay Round, contains in annex 1C the TRIPS Agreement.[51]

---

[49] According to Lanjouw and Mody (1996), among non-OECD countries in the 1970s and 1980s, Brazil "has been the clear leader: over 18 years between 1971 and 1988, Brazil granted 2,180 environmental patents". In comparison, India granted 384 patents in the 15 years between 1974 and 1988; the Republic of Korea granted 436 patents in the 13 years between 1976 and 1988; and China, with a relatively new patents system, had granted 279 patents by 1988. (*op. cit*., p. 563). Of the patents, 68 per cent were granted to foreigners in Brazil, 63 per cent in India, 44 per cent in the Republic of Korea and 36 per cent in China (*op. cit.,* p. 562).

[50] "Intellectual property is an essential component of an environment conducive to the creation and international transfer of technology" (see UNCTAD IX, Midrand Declaration and a Partnership for Growth and Development, para. 37).

[51] The Uruguay Round of Multinational Trade Negotiations, *Final Act Embodying the Results of the Uruguay Round of Multinational Trade Negotiations*, Marrakesh, Morocco, 15 April 1994.

86. The basic principles of the TRIPS Agreement refer to criteria and objectives regarding the contribution that the protection and enforcement of IPRs should make to the promotion of technological innovation and the transfer and dissemination of technology. In this new framework, patents are to be available for any inventions, in all fields of technology. One of the few justifications for excluding patentability is for the aim of avoiding "serious prejudice to the environment". The Agreement also refers to measures that countries may adopt to protect public health and nutrition and to promote public interest in sectors of vital importance to their socio-economic and technological development. These principles also provide that appropriate measures may be needed to prevent the abuse of intellectual property rights or practices which unreasonably restrain trade or adversely affect the international transfer of technology.

87. The strengthening of IPRs as a result of the implementation of the TRIPS Agreement is likely to have a mixed effect on the transfer of ESTs to developing countries. On the one hand, stronger and broader IPRs would enhance the bargaining position of technology holders *vis-à-vis* potential licensees. On the other hand, the implementation of stronger protection of IPRs in developing countries may be a necessary condition for a transfer of technology to take place.

88. The TRIPS Agreement provides a number of mechanisms aimed at fostering competition and innovation and restoring market forces when these are unjustifiably suppressed or distorted by the exercise of patent rights. One such set of mechanisms is dealt with under the heading of other "uses without the authorization" of the patent-holder. Developing countries may require "uses without the authorization" of the patentee on a variety of grounds, which are not limited by the Agreement. However, these impositions are subject to conditions that attempt to balance the patentees' interests against those of the public, and these might constitute impediments to an effective transfer of ESTs to developing countries.

89. Both the public-interest clause and the measures to prevent abuse (respectively stipulated in Article 8 of the TRIPS Agreement) can justify resorting to "uses without the authorization" of the right-holder (compulsory licensing). Article 31 requires the would-be licensee to seek a negotiated licence from the right-holder and, failing this, to pay equitable compensation. The refusal to grant a licence on reasonable terms and conditions could, in itself, justify the granting of a compulsory licence.[52] However, the implementation of such provisions in practice remains to be analysed and no actual cases were found in the preparation of this study.

90. The requirement that would-be compulsory licensees negotiate seriously with right-holders to obtain exclusive licences on reasonable terms should increase the pressure on patentees to accommodate pricing and other strategies to local market conditions. This, in turn, should lessen the need for governments to seek compulsory licensing in the first instance. Thus, the TRIPS Agreement does not limit the grounds under which a compulsory licence may be granted. It is useful to recall that Agenda 21 (Article 34.18.e) suggested the adoption of compulsory licences in the field of ESTs to prevent the abuse of IPRs, subject to the relevant international conventions and to "equitable and adequate compensation". Again, it appears that this provision has not yet been applied and no cases were found in the preparation of this report.

V. BUILDING NEW TRANSFER AND DIFFUSION MECHANISMS

91. The set of policies and measures that can be undertaken to enhance transfer of ESTs needs to take into account the prevailing policy orientation towards technology transfer, as shown in this study. Technology can be transferred through various channels such as trade (purchase of equipment, final goods, licences and services); investment (foreign direct investment and joint ventures and production); and the use of scientific results available in the public domain for the development of technologies within a firm.

[52] The practical effects of Article 31 of the TRIPS Agreement ("Other use without authorization of the right holder") in the context of the overall provisions of the Agreement and of the Paris Convention are a subject that merits further examination and research.

The importance of the different channels varies over time, involves the recipient and the supplier of technology in different ways, and requires different information and technological capabilities, and hence different sets of policies.

92. An effective process of technology transfer is essentially a process of "innovation" in product, process, organization or management routines for the firm adopting the new technology. A considerable body of literature dealing with the process of innovation shows that this is fundamentally an interactive process.[53] Firms are stimulated to change through their interaction with other firms -- suppliers or clients -- research institutions, business associations and other actors. Product design and quality improvements, adaptations required in order to utilize local inputs, and process changes that increase efficiency and reduce costs, may all be stimulated and in some instances supported through interaction amongst users and producers or between producers and other actors in the environment -- local or long-distance. An effective process of technology transfer, therefore, will require interaction between user firms and the producers and/or adaptors of technology. The policy environment is also critical in stimulating innovation, since it shapes the parameters within which decisions concerning the adoption of a new product, process, organizational structure or management routine are taken. Developing appropriate policies will thus require further study at the national level in those countries interested in promoting the use of ESTs by locally based firms.

93. A number of factors have to be considered. These include lack of interest or stimulus on the part of the originating R&D institutions in engaging in the technology transfer/commercialization process due to cultural norms (researchers versus entrepreneurs), lack of knowledge of the process, and lack of financing and institutional support in-house for finding potential partners. There are a number of possible solutions to these problems, particularly if the objectives are (a) to ensure that publicly funded R&D is commercialized, and (b) to facilitate the transfer of ESTs to developing countries and countries with economies in transition, thus avoiding their falling further behind in meeting the goals of Agenda 21. It should be noted that, in the developing countries, the vast majority of firms are small. Many are family-owned and have a tendency to be risk-adverse, particularly when it comes to the introduction of innovations based on unproven technologies. Support structures that provide assistance in training and in debugging will have to be put in place where they do not now exist. Most of these firms have difficulty in securing loans from local credit institutions, and financing will be needed to make change possible. Few have scanning and networking capabilities that would enable them to access and evaluate technological information. There is a need, therefore, to develop a support structure designed to provide information on ESTs available and ensure an effective transfer of these technologies to SMEs. Some of the broader mechanisms required to facilitate the transfer of ESTs to developing countries are discussed below.

94. An effective transfer and diffusion of ESTs to developing countries would thus require mechanisms that could cover the following set of tasks:

(i) the identification of ESTs;
(ii) their acquisition;
(iii) the assessment of their utility to developing countries;
(iv.a) the identification of potential users, most probably amongst SMEs in developing countries;
(iv.b) sensitizing them to the need to adopt environmentally sound technologies; and
(iv.c) creating an awareness of the accessibility of such technologies and the benefits (financial, quality of output, image/marketing, etc.) that they would bring to the firm;
(v) to ensure the adaptation of these technologies to these users at minimal cost;
(vi) to finance the process of adaptation;

[53] See, particularly, B. A. Lundvall, "Innovation as an interactive process: From user-producer interaction to the national system of innovation", in G. Dosi et al. (eds.), *Technical Change and Economic Theory*, London, Pinter Publishers, 1988, pp. 349-370.

(vii) to maintain contact with the users for follow-up and debugging.

95. A technology pool, such as an environmentally sound technology rights bank (ESTRB), could be one potential solution to the problem of identifying and acquiring environmentally sound technologies, i.e. tasks 1 and 2 above. Such a mechanism would closely cooperate with and complement the existing initiatives and networks described in chapter III of this study. As shown in this study, most technological breakthroughs in environmental protection and conservation are of a proprietary nature. An ESTRB would act as an intermediary for proprietary ESTs by making them available to developing countries under conditions to be negotiated on a case-by-case basis. As technologies may include both patented and unpatented know-how, an ESTRB would have to acquire not only the patent rights to but also the related enabling knowledge for each specific technology in order to make possible the mastery of the technologies in developing countries.

96. While the technology owner, either private or public, would retain exploitative rights in the industrialized regions, the mechanism would aim to increase developing countries' access to environmentally sound technologies by: (a) negotiating the acquisition and diffusion of such rights with private firms and other technology developers, including public institutions, on a fair commercial value basis; (b) accepting patents as donations from both private and public sources; and (c) initiating licences, commercial development agreements and "use" agreements with suitable "users" in the developing countries, under conditions to be negotiated case by case. The success of such a mechanism will depend on, among other things, reliable methods for the identification of available ESTs that could meet the needs of developing countries and are affordable. In this respect, there is a need for methodologies to develop inventories of ESTs and for the assessment of identified ESTs and their adaptability to developing countries' needs.

97. The effective transfer of technology, however, does not depend solely on the accessibility and the terms and conditions for the acquisition of technology, as is often assumed, but also on local demand conditions and, as stated in Agenda 21, on the prior "building of technical and managerial capabilities". An important element in the building of local capability for transfer of technology and innovation is the development of networks. The conditions for building such networks and possible structures are identified below:

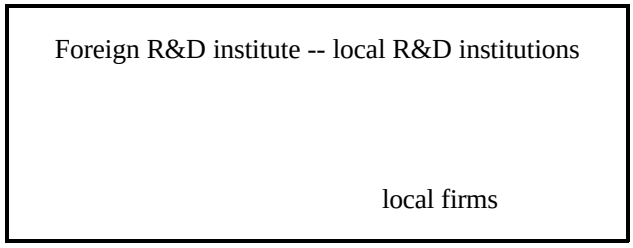
(a) First, the technology in question would have to be assessed in order to determine whether it will be usable by developing countries. It might be useful at this stage to put the originating research institute into contact with a network of other R&D institutions in developing countries which could assess the technology. Research and Technology Development Institutions (RTIs) that include local RTIs in both developed and developing countries already exist.[54] The principal tasks of this network would be to assess the utility of ESTs for potential users in the developing world (task 3, above), and ensure the adaptation of these technologies to user firms (task 5). The bulk of the work on adaptation would be undertaken by local RTIs in developing countries to reduce costs and ensure the capacity to undertake debugging (task 7) activities as required by their clients. Partnerships within the network between RTIs in developed and developing countries would provide additional capacity-building and facilitate debugging and the further adaptation of the technology, should these activities be necessary. The network would work closely with the private sector.

[54] The core for the development of a network of RTIs could, for example, be found in two existing networks: the World Association of Industrial and Technological Research Organizations (WAITRO) and the International Association of Technology Assessment and Forecasting Institutions (IATAFI), both of which draw their members from developed and developing countries. Other institutions can be progressively identified and added to this core, including regional institutions such as the Asian and Pacific Centre for Transfer of Technology (APCTT) in Asia, and national institutions, for example the Raw Materials Research and Development Council in Nigeria and the Scientific and Industrial Research and Development Centre (SIRDC) in Zimbabwe.

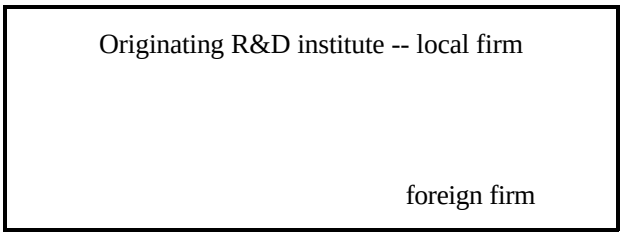
(b) Second, adaptation and further development of the technology might be required in order to move it from the laboratory to potential users. Here partnerships could be explored involving the originating R&D institution and R&D institutions in those countries where a potential exists for applying a technology. Chapter III provides a number of examples of such partnerships.

(c) Third, it would be necessary to encourage the development of pilot projects at home and abroad to show potential users that a technology is viable. The initiatives by the European Union described in chapter III could serve as a model for such projects.

(d) Fourth, it would be necessary to support linkages between research institutes, where the publicly funded R&D on ESTs was being carried out, and R&D institutions in other countries where there may be local user-firms (three-way partnerships). This would speed up the diffusion of the technology. An example of a three-way partnership might appear as follows



A variant of such a partnership might appear as follows



98. To further stimulate transfer and diffusion of ESTs in developing countries, a second network consisting of Centres for Innovation and Enterprise Development (CIEDs) might also be envisaged. These Centres would be identified from among existing business-related organizations in Latin America, Asia and Africa. The primary task of the CIEDs is to identify potential users and explore business opportunities for them, sensitize them to the need to adopt ESTs, and create awareness of the accessibility of such technologies and the benefits to be derived from their adoption. The CIEDs might also facilitate the search for funds to finance the process of adaptation (task 6). However, it is anticipated that the major cost of the adaptation process would be borne by the users themselves.

99. Thus, following identification of potential users for each type of technology, the CIEDs would play a critical role in forming potential users into user-consortia. For example, interested leather-tanning firms, dyeing firms, printing companies, paper and pulp manufacturers, chemical companies and other heavy polluters would be brought together into consortia. These consortia would collectively fund the adaptation process in local research and technology development (R&TD) institutions either through direct contribution or through local funding available for this purpose. The CIEDs would remain in contact with consortia members after the transfer and would play an intermediary role in the event of technical problems requiring further assistance from local or foreign R&TD institutions (task 7). They would diffuse the knowledge needed to overcome such problems as it becomes available and would progressively sensitize other local firms to the benefits that might be obtained through adoption of the "new technology". Newcomers would pay a fee equivalent to the share paid by consortia members for adaptation by local R&TD institutions. This fee would be used by the CIEDs to continue their work in the transfer and diffusion of ESTs. Since user fees would largely cover the local costs of tasks 4, 5 and 7, the role of foreign assistance in the process of transferring

and diffusing ESTs could then be limited to the following activities: financing tasks 1 and 2 -- identifying and evaluating the suitability and adaptability of environmentally sound technologies for transfer to developing countries and participating in the financing needed to acquire the rights to ESTs.

100. Such a mechanism, building on and closely working with the existing initiatives described in chapter III, and mechanisms discussed above, could create a framework within which the necessary identification, assessment, adaptation and post-transfer follow-up could take place. It ensures that transfer of ESTs is effective by building technological capacity in both local firms and research and technology institutions, and promoting the interaction between them that is needed to stimulate and sustain a process of innovation. It does so, moreover, without prejudice to the form in which ESTs are acquired. Incremental support would be required to launch the process of creating a mechanism of this sort on a global scale.

VI. MAIN FINDINGS AND ISSUES FOR FURTHER CONSIDERATION

101. The findings of the study show that public sector funding remains a major source for R&D activities, although in recent years the public sector share in total R&D spending has declined in most countries covered by this study (see appendix 1). Increasingly, the commercialization of publicly funded technologies has been emphasized with the objective of cost recovery and market-based diffusion of technologies.

102. In all countries, the role of publicly funded R&D in the development of ESTs is significant. Through both policy and public funding, the public sector continues to be an important motor in the development of ESTs. As figure 3 shows, there are many steps in the development, transfer and diffusion of ESTs for which public policies, initiatives and support structures provide a critical stimulus.

103. Although, as figure 3 also illustrates, ESTs are in some ways different from other technologies, the country case studies reveal that, in general, public control or ownership of the results of publicly funded R&D, including ESTs, and their transfer and commercialization is rarely exercised. In some countries, ESTs generated from publicly funded R&D activities are owned either directly by the research institutions concerned or through some form of co-ownership arrangement with the company(ies) commercializing the technology; in others, ownership is fully transferred to private entities. But overall, public sector involvement in the financing of R&D has few implications for the mode of ownership, commercialization, diffusion or transfer of these technologies.

104. The study reveals that both developed and developing countries undertake R&D on ESTs and that a broad range of ESTs is available to meet the needs of developing countries and countries in transition. However, only a small proportion of ESTs resulting from publicly funded R&D are patented, commercialized or transferred.[55] Among the reasons highlighted were the costly and lengthy process of obtaining patent rights, the lack of knowledge about the business aspects of technology development, the absence of an incentive structure conducive to the commercialization of research results, and the fact that much of the R&D activity is still too upstream in many countries. Consequently, relatively few of the technologies generated in public R&D institutions and laboratories reach the development, commercialization and transfer stages, and the mechanisms available for moving publicly funded technologies from public institutions to the commercialization stage are limited. In cases where patents on publicly funded ESTs were obtained and successful transfer has taken place, partnership with private enterprises has often been the main channel, though even here much more might have been expected.

Figure 3: Similarities and differences between ESTs and other technologies

[55] See, for example, BMBF (1997), p. 65.

	ESTs	*Other technologies*
Main drivers	Public policy-regulatory policies, or their absence; multilateral environmental agreements	- Market forces: demand, competition, production - Bottlenecks - Etc.
Finance	Public funding vital; lack of venture capital	Largely private funding, including reinvested earnings, venture capital and sale of stocks
Location of R&D	Mainly in universities, public R&D institutes and laboratories	Mainly enterprise-based
Mechanisms for transfer	Transfer to private sector; emerging role for public-private sector partnerships (e.g. university-enterprise cooperation)	New structures through inter-firm R&D collaboration as well as partnerships of firms with public R&D
Commercialization	Increasingly private; many SMEs involved; support structures and incentives needed	Private
Application	Often site or locationally specific applications, some ESTs could be applied globally (e.g. CFC substitutes)	Increasingly global
Transfer to developing countries and countries with economies in transition	Commercialization; ODA; sometimes with funding from multilateral sources (e.g. multilateral fund under Montreal Protocol, GEF)	Almost exclusively through private commercialization

105. In both developed and developing countries, it is necessary to strengthen the policy framework and the support structures needed for the commercialization and transfer of publicly funded ESTs within and between countries. From the limited transfer and commercialization of ESTs resulting from publicly funded R&D within domestic and international environments and from the numerous statements to the effect that such technologies should be transferred, it is evident that market mechanisms are not yet sufficient to ensure a broad diffusion of ESTs everywhere. At the same time, however, global environmental degradation is worsening. Some of the key elements in the transfer of ESTs and mechanisms likely to bring about a more effective transfer of technology to all countries, particularly those in the developing world, have been discussed in chapter V. In this context, there is a need for governments to develop a variety of demonstration projects (including the pilot phase) for the transfer and diffusion of publicly funded ESTs, create better sources of information about the availability of ESTs originating from public R&D, and stimulate partnering between public and private sector institutions in order to ensure the transfer and more rapid diffusion of ESTs. This point may also require considerable sensitization of the R&D community to the need to transfer their results to users, either through working together to further develop the process/product, and build a pilot plant for testing and adaptation, or through licensing and other commercial means.

106. In summary:

(a) Many governments covered by this study explicitly refer in their public policy statements to the need to share ESTs with the developing world. Nevertheless, they have not yet incorporated formal policy measures to implement the recommendations contained in Agenda 21 on the issue of technology, including publicly owned technologies. Overall, and relative to these public policy statements, the extent to which and the pace at which ESTs are being transferred to developing countries and countries with economies in

transition appear inadequate when compared with the expectations raised prior to and at the United Nations Conference on Environment and Development (UNCED) in 1992.

(b) The problem, however, is not one of incompatibility between the policy objective of public R&D funding for domestic industrial competitiveness and the need for accelerated technology transfer in the area of ESTs. Rather, as the case studies illustrate, publicly funded technologies are increasingly commercialized on the basis of market mechanisms and cost recovery criteria. Most governments equate transfer of technology with commercialization, including in the area of ESTs. With this understanding, they appear to fulfil their mandate under Agenda 21 by transferring the results of publicly funded R&D to private domestic firms. Much of the publicly funded R&D, however, is never transferred, not even to local firms.[56] There is thus considerable room for the role that governments could play in exploring new mechanisms for the transfer and diffusion of ESTs resulting from publicly funded R&D.

(c) While the predominant pattern for the transfer of ESTs, both at the national and international levels, is "commercialization", some efforts have been made to aid the process of transfer of ESTs through bilateral and multilateral initiatives which are of a "classical" ODA type or are based on promoting new forms of public-private partnership for technology transfer that involve some public support. Thus, as shown in this study, several countries have launched initiatives, cooperation programmes and pilot projects that could serve this purpose, including policies and mechanisms to ensure financing of the various phases in the process of technology transfer. A number of these -- which have been described in chapter III -- are innovative models of technology transfer which could be adopted to accelerate the implementation of technology-related provisions in Agenda 21, including those referring to publicly owned technologies. These initiatives have wide-ranging objectives: creating awareness; finding partners; launching a pilot project; developing policies and programmes that encourage R&D institutions to transfer technology; creating adequate funding mechanisms for them; and finally, establishing policies that actively pursue technology partnership among enterprises. While these are promising developments, they are often scattered individual programmes, and funding for such activities remains relatively low.

(d) In the above context, new policy initiatives may be required and support structures need to be strengthened. Thus, some of the initiatives discussed in chapter III deserve further attention. While an assessment of these programmes goes beyond the scope of the present study, this could be one area for further investigation by the Commission on Sustainable Development. Such a study could focus, in particular, on whether the initiatives identified above might concentrate more on publicly funded or publicly owned technologies than they currently do, especially with regard to technologies that are not being commercialized. Another focus could be on increased cooperation between the initiatives already in place for ESTs' transfer and public R&D institutions, which usually lack the budget needed to carry out the transfer themselves. Linkages between ODA and public R&D institutions could improve and strengthen the transfer of ESTs and prevent companies in the developing world from falling further behind in the use and diffusion of ESTs. Incorporating the transfer of publicly funded ESTs into ODA policies could also be considered. Chapter V describes how new transfer and diffusion mechanisms could bring all these elements together.

(e) Another area for further investigation could be the legal and institutional obstacles confronting the transfer of ESTs. Chapter III briefly illustrated some of these, and chapter IV pointed out that the legal and institutional framework governing the commercialization and transfer of ESTs does not generally differ from that of technology in general. Here one could argue that governments might consider exploring the possibility of exempting ESTs from some of the relevant legal provisions. However, given the difficulty in defining "ESTs" in the first place, this would require reaching a common understanding as to what types of technologies could be considered for such exemptions. The technologies listed in figure 2, as well as those needed under multilateral environmental agreements, could form the core of such a list. It would be more

[56] Up to two-thirds, according to the innovation literature.

difficult to include ESTs with dual-use applications. Generally, in our survey of policy and institutional factors, IPRs -- although sometimes involving costly and lengthy processes -- did not seem to be the major obstacle in the transfer of ESTs. On the contrary, it was argued in the discussion that the presence of an effective IPR system facilitates technology transfer. On the other hand, provisions that do not permit the transfer of publicly funded technology to firms in other countries -- even when no domestic firms are ready to commercialize them -- could be regarded as an effective obstacle to the diffusion of ESTs.

107. As the above summary illustrates, there is considerable room for action by governments committed to the broad diffusion of ESTs on a global level, particularly of technologies that are the result of publicly funded R&D. Specifics could be built into the agreed recommendations of the International Expert Meeting in Kyongju for the sixth session of the Commission on Sustainable Development.

❖ ***ATTACHMENTS*** ❖

Appendix 1 - Gross domestic expenditure on R&D

Appendix 2 - List of contributors to the project and studies undertaken

Gross domestic expenditure on R&D (GERD) **APPENDIX 1**
-- public percentage of total GERD --
1985 - 1995

Year/type	1985	1990	1995
Country Grouping	*Public % of total GERD*	*Public % of total GERD*	*Public % of total GERD*
Overall OECD	43.0	37.8	34.5
United States	50.3	43.8	36.1
Canada	48.9	44.3	37.7
European Union	44.4	40.9	33.1
United Kingdom	42.2	35.5	33.3
France	52.9	48.3	--
Japan	21.0	18.0	22.4
Germany	37.6	33.9	37.1
Korea (Republic of)		17.0	18.2
Czech Republic	--	30.6	34.9
India	88.5	87.3	84.6
Brazil			82.0*

Sources: OECD, UNESCO, and various national sources compiled by UNCTAD.
* = year 1994.

List of contributors to the project and studies undertaken **APPENDIX 2**

COUNTRY CASE STUDIES

Brazil:	Ms. Léa VELHO, University of Campinas, São Paulo, Brazil, and Mr. Paulo VELHO
Canada:	Mr. Trent GOW and Mr. Christopher HILKENE, of Thompson Gow and Associates, Toronto
Czech Republic:	Mr. Bedrich MOLDAN, Charles University, Prague
France:	Mr. Bertrand WARUSFEL and Mr. Alain ESTABLIER, of Warusfel & Associates, Paris
Germany:	Dr. Hans-Peter WINKELMANN, Institute for Environmental Research (INFU), University of Dortmund, Dortmund
India:	Mr. Upendra TRIPATHY, Director, Environment, Government of India, Bangalore
Japan:	Dr. Shuichi SASAKI, Global Industrial and Social Progress Research Institute, Tokyo, and Mr. Shouchuan ASUKA-ZHANG, Center for Northeast Asian Studies, Tohoku University, Sendai
Korea, Republic of:	Professor Il Chun KWAK, Department of Regional Development, Kyungwon University
United Kingdom:	Mr. Andrew J. BLAZA and Ms. Rita van der VORST, Imperial College Centre for Environmental Technology, London
United States:	Mr. Woody CLARK Jr., University of California at Davis, California

LEGAL REGIMES CASE STUDIES

France/EU:	Mr. Bertrand WARUSFEL and Mr. Alain ESTABLIER, Warusfel & Associates, Paris
MERCOSUR countries:	Mr. Carlos CORREA, University of Buenos Aires
United States:	Ms. Rebecca EISENBERG, University of Michigan Law School

STUDY ON ROLE OF UNIVERSITIES IN THE GENERATION OF ESTS

Professor Kumsoo KIM,
Department of Chemical Engineering, Columbia University,
New York

Preparatory project group:

L. Mytelka, P. Roffe, D. Koenig and T. Tesfachew,
United Nations Conference on Trade and Development,
Geneva

D. Pilari,
United Nations Department of Economic and Social Affairs,
New York

J. Aloisi de Larderel and S. Gorman,
United Nations Environment Programme - Industry and Environment Centre,
Paris

J. Whitelaw,
United Nations Environment Programme,
International Environmental Technology Centre, Osaka

Commission on Sustainable Development
Sixth Session
20 April - 1 May 1998

Background Paper No. 28

INFORMATION ON THE NATIONAL CLEANER PRODUCTION CENTRES PROGRAMME

United Nations Industrial Development Organization

Contents

Note to the Reader:

This activity report is cumulative and is updated every 6 months. It is intended to inform the reader about the accomplished and ongoing activities of the individual centres.

General information on the NCPC programme and on Cleaner Production is available in Annex II and from other information sources. A selected list of UNIDO/UNEP publications is attached in Annex III.

CP Information on the Internet can be accessed as follows:

UNIDO: http://www.unido.org

Select: “Activities”, then go to: “Cleaner production network” or “Cleaner production information”

UNEP: http://www.unepie.org

Background

1. The National Cleaner Production Centres (NCPC) programme is a joint initiative by the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme, Industry and Environment Programme Activity Centre in Paris (UNEP IEPAC, hereafter referred to as UNEP). UNIDO is the executing agency, with UNEP assisting in the provision of strategic guidance and professional environmental support.

2. Phase I of the NCPC programme began in 1994 with the start of eight NCPCs. These eight centres are located in Brazil, China, Czech Republic, India, Mexico, Slovak Republic, United Republic of Tanzania and Zimbabwe. The eight centres were selected from solicitations received from 39 institutions in 25 countries. Phase II activities have already started with the funding of two new centres, Hungary and Nicaragua, and of an already existing CP Centre in Tunisia, started by USAID in 1992. Cleaner production projects, which are expected to lead to the establishment of NCPCs, have started in Uzbekistan, Croatia and Viet Nam.

3. The programme is funded from a number of sources. The Government of the Netherlands funds the centres in China, India, Mexico, Tanzania and Zimbabwe, and the Government of Austria funds the centres in the Czech Republic, Hungary, Nicaragua and Slovakia. UNEP also provided substantial funding for the programme in Phase I. The centre in Brazil is funded through a self-financed trust fund. The centre in Tunisia, initially established with assistance from USAID, is supported by Norway. The cleaner production projects are funded by the Czech Republic (Croatia), Japan (Uzbekistan) and Sweden (Viet Nam).

Objectives of the National Cleaner Production Centres Programme

4. The objective of the NCPC programme is to build national capacity in the field of cleaner production (CP). The programme builds capacity to provide four services: in-plant assessments, training, information dissemination and policy advice. All these services are interrelated and strongly support each other:

In-plant Assessments. Through in-plant assessments, an NCPC shows that the CP concept can be applied to any industrial sector and that pollutant reduction can be financially attractive. In-plant assessments create examples of successful CP applications that have a direct positive impact on the environment and that can be copied by other enterprises.

Training. Through training, an NCPC develops a core of national CP consultants, ensures that plant personnel participating in assessments retain the ability to implement additional CP measures and informs other relevant parties, such as subsector organizations, governments, research institutes, financial institutions, universities and consultants, of the advantages of CP.

Information Dissemination. Through information dissemination, an NCPC provides technical information (e.g., available technologies for solving environmental problems in sector-specific processes), shares experience with interested partners through CP case studies and promotes its services. An effective information dissemination programme is essential for ensuring that CP consultants can provide SMIs with information about the most appropriate CP techniques and technologies.

Policy Advice. Through policy dialogue, an NCPC aims to modify national legislation and policies to assign priority to preventive environmental management and to support effective environmental regulation. The latter involves not only administrative measures, such as licencing, but also economic measures such as realistic disposal charges and market priced energy and water.

5. Phase I support for the Centres will end in mid-1998. Phase I has emphasized building capacity to provide two of the four core NCPC services, in-plant assessments and training, because the outcomes from providing these services are essential building blocks for the other two services. Phase II of the NCPC programme aims to enhance the Centres' nascent capacity for the other two core NCPC services -- information dissemination and policy dialogue. More importantly, it will use capacity of the NCPCs to: (a) establish CP expertise for in-plant assessments and training in other institutions (designated as strategic allies) already advising SMIs on technology choices; and (b) work with other institutions (designated as cooperating partners) that are already engaged with SMIs in complementary activities such as environmental regulation, business support and financial services. The NCPCs, together with their strategic allies and cooperating partners, will constitute the core of the CP institutional network in each country. Phase III of the NCPC programme, approximately one-third of the annual support provided in Phases I and II, is envisaged to cover national and international networking, provision of technical information by the NCPCs to their strategic allies and cooperating partners and training and/or advice to new strategic allies. By the start of Phase III, the NCPCs should have the potential to shift from where their main clients and level of work are, at the micro level, with enterprises, leading to consultancy based NCPCs to where their main interest and level of work are, at the meso level, with strategic allies and cooperating partners, leading to effective national networks. This new level should result in a much higher outreach to SMIs.

Organizational Structure

6. The programme has a relatively lean organizational structure. Each NCPC is directed by an experienced country national, hosted within a local organization, and receives guidance from a national advisory board.

7. The NCPC programme organizes annual meetings to evaluate the progress of the programme, to exchange experience, and to discuss future activities to be undertaken by the centres. The list of contact persons and addresses is included in Annex I.

Major Achievements

8. The table on the next page summarizes the main achievements of the NCPCs in the first three years of the programme (1995 - 1997). At the time of the review, the number of plants which participated in in-plant assessments was 341, the number of trained consultants 707; 15,090 persons participated in seminars and 6,580 in workshops. 19 newsletters and 34 publications had been issued. In addition, the NCPCs receive attention by local TV and radio stations and the press.

KEY INDICATORS OF THE PROGRESS OF THE ONGOING NCPC PROGRAMME (as of 31 October 1997)

Country	Start of operation	**Overall assessment of progress**	Number of plants which have participated in in-plant assessments		Number of trained assessors		Number of participants		Newsletters issued	Number of publications	Press coverage		
			on-going	completed	on-going	completed	seminar	workshop			TV	Radio	Press
Brazil	September 1995	Satisfactory, as planned	21	1	25	18	3,000	460	1	5	✔	✔	✔
China	June 1995	Highly satisfactory, more than planned	1	66		41	9,390	4,220	8	5		✔	✔
Czech Republic	November 1994	Highly satisfactory, more than planned	14	46	40	146		80		5	✔	✔	✔
Hungary	May 1997	Satisfactory, as planned	16		11		300			2	✔	✔	✔
India	July 1995	Highly satisfactory, more than planned	8	9		48	790	650	3	5	✔	✔	✔
Mexico	November 1995		6	13	7	4	960	210	2	3			
Slovak Republic	November 1994			69	148	179		70	2	9			
Tanzania	August 1995		16	16	15		120	50	1				
Tunisia	September 1994	Highly satisfactory, more than planned	6	14		10	250	650	1	3	✔	✔	✔
Zimbabwe	March 1995	Satisfactory, as planned	8	11	7	8	280	190	1	2		✔	✔
All Centres		**Highly satisfactory, more than planned**	**96**	**245**	**253**	**454**	**15,090**	**6,580**	**19**	**34**			

Note: The exact figures in the table above should be taken with some reservations as the Centres have used slightly different definitions, e.g., to distinguish between seminars and workshops.

Overview of Progress per NCPC

BRAZIL	***Organizational structure:*** The National Cleaner Production Centre of Brazil (BCPC) is located at its host institution, the Servico Nacional de Aprendizagem Industrial (SENAI), in Porto Alegre. The office employs 13 staff members. It also relies on external consultants (mechanical and chemical engineers). The activities of BCPC started in July 1995 when the Trust Fund Agreement with SENAI was signed in the presence of the Governor of the state of Rio Grande do Sul. The Centre works closely with STENUM, Austria, who provides consultancy.
	In-plant assessments: The first in-plant assessment organized by the BCPC was in the metalworking sector and involved 5 medium-scale enterprises in the cities of Porto Alegre and Caxias do Sul. The project started in August 1996, when the first training workshop took place with the assistance of STENUM. In October 1996, the Centre initiated 2 additional demonstration projects in the agro-industrial sector (slaughterhouse, canned fruits, rice and fishing industry) in Caxias do Sul and Pelotas and 1 regional project near Porto Alegre. In March and August 1997, international missions took place, their goal being to provide additional technical support to the on-going demonstration projects and to start new ones in specific areas, e.g. development of a regional logistic system for tire production. The in-plant assessments resulted in minimization of hazardous wastes, solid wastes and energy and, thereby, in substantial monetary savings. A new demonstration project is under way in the footwear sector. Other assessments are planned for the viniculture and dairy sectors.
	Training. In 1995, the BCPC team participated in a workshop on Environment Management Systems, organized by STENUM in Graz, Austria, and took part in the UNIDO-NGO forum on cleaner industrial production in Vienna. In co-operation with the STENUM expert, the BCPC conducted training workshops for the companies participating in in-plant assessments. A total of 22 national consultants are being trained in conjunction with these assessments. 17 workshops on the CP methodology for representatives of government institutions, industrial associations and universities in Rio Grande do Sul were held. In total, the BCPC has trained 460 people in specific workshops; 62 company staff and a specialization course in CP is planned in 1998 with the Federal University of Rio Grande do Sul.
	Information dissemination. The Centre's information strategy includes an indirect campaign (publications and radio talks) and a direct campaign (seminars, presentations and on-site visit). In July 1996, the BCPC started publishing a newsletter *"CNTL Informativo"*. The management of the BCPC organized 322 awareness seminars. Publications include 2 folders, 1 newsletter, 1 diagnosis paper of the metal-mechanic sector, and 3 papers presented to international seminars. The Centre's staff participated in 38 national seminars and five international seminars.
	Policy Dialogue. The BCPC has organized 12 seminars for a total of 300 representatives of the government. In cooperation with the Environmental Committee of the state of Rio Grande do Sul, the Centre prepared a comprehensive environmental policy proposal on the application of CP on a sustainable basis in the state of Rio Grande do Sul. This proposal was submitted to the State Ministry of Environment.

C H I N A	***Organizational structure:*** The China National Cleaner Production Centre (CNCPC) is hosted by the Chinese Research Academy of Environmental Sciences, an institution of the National Environment Protection Agency. The China NCPC has 11 staff members. CNCPC started its activities in June 1995. The CNCPC has provided assistance in setting up 12 associated cleaner production centres and has established a network of 60 institutions engaged in CP in China. The counterpart institution is IVAM in the Netherlands.
	In-plant assessments: Although CNCPC is based in a government institution, most of the in-plant assessments take place in the semi-private sector. To date, CNCPC has undertaken assessments in 66 plants including pulp and paper mills and breweries. The mills expect joint savings of 15 million yuan and the breweries of 4.2 million yuan annually. Company personnel and management, as well as representatives from other companies and various semi-governmental and governmental organizations, attended the workshops. UNIDO sectoral experts provided technical assistance. CP assessments were initiated in three breweries. Further audits are planned in the pulp and paper, petrochemical, pharmaceutical and metal-finishing sectors.
	Training. To date, the CNCPC has provided training for 12 cleaner production centres in China. Most of these are provincial cleaner production centres. In total, 41 consultants have been trained in CP. In June 1997, the CNCPC started a training programme on ISO 14001 Environmental Management Systems. The training focuses on CP as a tool for achieving targets set under the ISO 14001 Management System. A one-week training course was offered to senior officers of the Moroccan Ministry of Industry and Trade in November 1996.
	Information dissemination. CNCPC produces a newsletter every two months and prepares training materials for self-audits. A documentary on CP was produced for broadcasting on Chinese state television. Guidelines have been produced for five sectors, among which are the metal finishing, organic chemicals, silk dyeing and printing sectors. CNCPC also updated the Chinese World Bank Cleaner Production audit manual. The centre has trained 4,220 people at focused workshops and 9,388 people have participated in awareness-raising seminars. The CNCPC is in the process of establishing a network of CP actors in China. At the first meeting, it drew together 66 Chinese organizations that are interested in CP. Most of these organizations can play a facilitating role in introducing the concept country-wide. CNCPC also presented papers at several meetings, including the First Asian-Pacific Meeting on the Establishment of Regional Hazardous Wastes Centres, held at Beijing, and organized by the Basel Convention, and the Fourth High Level Seminar on Cleaner Production at Oxford, UK, organized by UNEP, in September 1996.
	Policy Dialogue. The CNCPC has been lobbying for a long time for the inclusion of CP into environmental impact assessments and for establishment of a national certification system for CP consultants. These efforts are about to bear fruit.

C Z E C H

R E P U B L I C

Organizational structure. The Czech Cleaner Production Centre (CCPC) is an independent non-governmental organization. The office consists of four staff members. CCPC cooperates closely with a network of national CP experts who were trained in a three-year-long capacity building programme financed by the Government of Norway. CCPC became operational in January 1995. Cooperation with the counterpart institution, STENUM (Austria), started in March of that year.

In-plant assessments. In 1995, CCPC started three demonstration projects in different places: in the city of Decin in Northern Bohemia, in the city of Zlin, and in a cluster of municipalities on the upper reaches of the Svitava River. The municipalities of Decin and Zlin are making financial contributions to the programme. The main results of these demonstration projects are documented in 25 case studies. Assessments in the Svitava area are now being conducted exclusively by national experts. In May 1997, the CCPC started a long-term training course on integrating EMS (environment management systems) and CP. The aim of this course is to train 15 national experts on CP+EMS and to implement this system in 6 companies.

Training. CCPC has trained 61 national CP experts, and another 74 representatives from the private and public sector participated in specific workshops. Graduates of the training programme have joined the Association of Managers for Cleaner Production (AMCP), which provides training and advisory service to national industry. The CCPC is providing experts in implementing CP projects in Croatia and Uzbekistan.

Information dissemination. With the financial support of the Ministry of Industry, CCPC has developed a CP manual for Czech industries. The centre has also published a manual for the state administration. In November 1996, CCPC and two Czech companies participated in the expert forum - "Cleaner Industrial Production in Central and Eastern Europe: Technology Transfer and New Opportunities for Cooperation". The forum was organized by UNIDO in cooperation with the Austrian non-governmental organization, OEGUT.

Policy Dialogue. CCPC submitted to the Ministry of Environment a report focusing on CP priority sectors, the application for CP labeling of products, the country's CP potential and a plan on how to realize it. At the beginning of 1997, CCPC was selected by the Ministry of Environment to act as counterpart for a CP programme in Croatia that is being financed by the Government of the Czech Republic. The director of CCPC has been appointed as one of the five members of the Executive Committee of the European Round Table of Central and Eastern European Countries.

HUNGARY

Organizational structure. The National Cleaner Production Centre of Hungary (HCPC) is located at its host institution, the Budapest University of Economic Science, and cooperates with a number of national institutions involved in CP in Hungary. The office consists of five staff members, including the director. The NCPC affiliate opened in Miskolc in January 1998. HCPC started preparatory activities in January 1997 and prepared a work plan, which the advisory board discussed and approved on 8 May 1997. The official inauguration of the HCPC took place on 12 May 1997 and the Advisory Board met on 9 December 1997 and revised the work plan and the budget of the NCPC. The counterpart to the Centre is STENUM, Graz, Austria.

In-plant assessments. Currently, the HCPC is preparing the first workshop for two regional CP projects in Salgotarjan and Dorog. These projects are based on the Ökoprofit methodology, which has been developed by STENUM, and are carried out in close cooperation with the two municipalities.

Training. In September, the staff of the centre and 7 national experts took part in an in-depth CP training, which was organized by STENUM in Graz, Austria. Furthermore, the topic "cleaner production" has been included in the curriculum of environment management courses at the University of Economics.

Information dissemination. The director and the staff of the centre have organized various CP awareness seminars in Hungary. The HCPC has been requested to organize the following two international conferences: TECHCOM in May 1998 and the European Cleaner Production Round table in 1999.

Policy Dialogue. The HCPC is participating in the establishment of a national accreditation body for EMS (environment management systems) and is a member of the National Accreditation Committee. Also, the HCPC is taking part in the development of economic and legal conditions in order to promote the CP concept, e.g. creation of an environmental insurance system for companies, where the fee is based on the environmental performance of the company.

INDIA	***Organizational structure:*** The National Cleaner Production Centre of India (ICPC) is based at the National Productivity Council in New Delhi but is an independent entity. The office consists of three staff members, including the director. India has a well-organized network of productivity councils that has proved to be very effective for the promotion of CP. The advisory board consists of six members from the Council, government institutions and the Confederation of Indian Industry. ICPC was able to start its activities in July 1995. The centre is very advanced at the technical level and has now started to receive requests from state governments who are willing to pay up to US$ 140,000 for the establishment of regional centres. The counterpart recently changed from DTI, Denmark, to IVAM Environmental Research, The Netherlands.
	In-plant assessments: ICPC developed a checklist with criteria based on those used by the EP3 programme of the United States Agency for International Development for the selection of sectors and companies. Using this checklist, it selected five sectors for assessments: edible oils, dairy, hosiery, electroplating and dyes and dye intermediates. The hosiery sector was selected for the first demonstration (nine companies). ICPC received assistance from a DTI expert in textiles. Late in 1996, the centre started in-plant assessments in four textile dyeing factories. Part of the assessment is a CP circle. This is a group of companies that could not be directly involved in the assessments, but that follow the project and apply the lessons learned in the assessment. The group is guided through regular meetings organized by the centre. After the ICPC has conducted the first assessments, private consultants trained by the centre are, in some cases, able to continue with assessments on a cost recovering basis.
	Training. Together with regional cleaner production centres and branch organizations, ICPC organizes CP workshops. In 1995, five workshops attracted 200 people. In 1996, the workshops attracted another 300 participants. The centre is also assisting the National Institute of Small-scale Industry Extension Training in developing CP courses. The centre has trained a total of 48 CP consultants.
	Information dissemination. Awareness programmes are being developed with regional productivity centres and industry associations. So far, 15 of these workshops have been conducted. Several awareness workshops were held in collaboration with other organizations such as the Association of Women Entrepreneurs of Karnataka in Bangalore. A CP roundtable conference and a workshop for the hotel industry were also organized. A total of 1,440 persons have participated in the workshops and seminars organized by the ICPC. Another 600 were addressed during events organized by other organizations. The ICPC has also participated in several international meetings. ICPC has published a booklet, "Cleaner industrial production: all you wanted to know but could not ask", and a guide, "From waste to profits: guidelines for waste minimization". It also distributes a technical manual and a video on the DESIRE project. TV presentations were given.
	Policy Dialogue. A study assessing the existing industrial and environmental policies with respect to CP has been started. The study will also formulate appropriate policy measures that can be taken to promote and stimulate the adoption of CP by Indian industries.

MEXICO	
	Organizational structure: The National Cleaner Production Centre of Mexico (MCPC) is based at its host institution, the Instituto Politécnico Nacional at Mexico City. The activities of MCPC started in December 1995, when the modalities of operation were signed and the director was nominated. The office employs five staff, including the director. The MCPC signed a working agreement with Canacintra (an industry association for SMEs) and cooperates closely with the EP3 programme of the United States Agency for International Development. The counterpart institutions are the University of Massachusetts, USA, and IVAM, The Netherlands.
	In-plant assessments: In February 1996, the director and deputy director of MCPC participated in a one-week training programme at an EP3 demonstration project involving in-bond assembly plants in the Reynosa-Matamoros area near the northern border of Mexico. In August 1996 the first assessment for the electroplating sector began. The six participating companies cooperated closely with international experts from EP3 and the MCPC. Based on the results of this project, a CP manual was elaborated and presented at a workshop for the electroplating sector. Currently, five companies are taking part in a second phase of the project. In February 1997, the MCPC started the second assessment project in the foundry sector. The project involves seven companies from four cities: San Luis Potosi, Querétaro, México D.F. and Saltillo. The project is carried out with the assistance of international CP experts from IVAM and a UNIDO senior expert in the foundry sector. The third assessment project was initiated in September 1997 and involves seven companies from the chemical sector.
	Training. In cooperation with the Lowell Center of the University of Massachusetts, the first in-depth training activities started in August 1996, when national experts and the staff of MCPC received training in the CP concept. In September 1997, the MCPC organized a train-the-trainer workshop with the assistance of the Lowell Center. A total of 1,170 representatives from the private and public sector participated in the awareness seminars and workshops, not including those held in conjunction with in-plant assessments.
	Information dissemination. Nine hundred people participated in the inaugural meeting of the Advisory Committee in June 1996. On that occasion the director of MCPC held a seminar for the participants to raise their awareness of CP. The Centre has issued two publications in cooperation with the Instituto Politécnico Nacional and has obtained television, radio and press coverage.
	Policy Dialogue. Policy dialogue recently started with the Ministry of Environment.

SLOVAKIA

Organizational structure. The National Cleaner Production Centre of Slovakia (SCPC) is based at the Slovak Technical University in Bratislava. SCPC started operation in February 1995, when 35 CP advisers and trainers completed the Norwegian-financed programme. Cooperation with the counterpart institution, STENUM, started in the same month. Like the NCPCs in the Czech Republic and Hungary, SCPC follows the method applied by STENUM in the Ökoprofit project in Graz, Austria; the method focuses on cities and regions.

In-plant assessments. In April 1995, SCPC organized the first workshop of the regional assessment project in the city of Martin. The ten participating companies represent various sectors, such as brewery, energy supply, metallurgy (Martin Metal), agriculture, glass production (Skloobal Nemsovar), hospital and wood furniture. In February 1996, the second regional assessment project started in the city of Trnava. Nine companies from the agro-industry and the chemical industry sectors, and the municipality of Trnava are participating in this project. In April 1997 the results of the Trnava project were officially presented. In 1997, two new regional CP projects in Trencin and Ruzomberok were initiated. These projects are carried out only by national experts.

Training. In November 1995, 11 Slovak experts participated in a five-day workshop on environmental management systems (EMS), organized by STENUM. During the demonstration projects in Martin and Trnava, ten consultants received in-depth training in CP. In total - including the Norwegian CP project - the centre has trained 186 national CP experts, consultants and managers. In 1997, the SCPC has created a Club of national CP experts and managers. In October 1997, a long-term training course on EMS and CP was started. Similar to the training organized by the Czech Centre, the EMS+CP course focuses on training of 15 national experts and implementation of EMS+CP at five national companies, to meet the demands of ISO 14000.

Information dissemination. In its first 36 months of operation, the SCPC organized 28 CP workshops and introductory seminars for participants from industry, services, municipalities and research and development institutions. It published a 28-page brochure on the Slovak CP programme, one newsletter and seven articles in bulletins and newspapers, and received press and radio coverage. A conference on cleaner production in Slovakia was held in June 1996. At that time, the Club of Cleaner Production Experts and Managers was formed. In February 1997, the most recent meeting of the Club's steering committee took place in Bratislava. In September 1996, in cooperation with SUSTAIN Austria, SCPC organized an international conference with the theme "High Tech and Sustainability". In the same month, the director participated in the Fourth High Level Seminar on Cleaner Production at Oxford, organized by UNEP. In November 1996, SCPC and two Slovak companies participated in the expert forum "Cleaner Industrial Production in Central and Eastern Europe: Technology Transfer and New Opportunities for Cooperation". The forum was organized by UNIDO in cooperation with the Austrian non-governmental organization OEGUT. About 100 representatives of the Austrian public and private sector participated. In 1997, the SCPC organized the second Slovak Cleaner Production Conference and the conference "Glass Industry and Environment".

Policy Dialogue. SCPC prepared several reports for the Government and the Ministry of Economy, the most important ones being "Cleaner Technologies in Slovak Industry" and "Development of Biotechnologies". In addition, it proposed that the Ministry of Economy should include CP in its document "Industrial Policy in the Slovak Republic". This proposal was approved by the country's Parliament.

UNITED REPUBLIC OF TANZANIA

Organizational structure. The National Cleaner Production Centre of Tanzania (TCPC) is hosted by the Tanzania Industrial Research and Development Organization (TIRDO). It has five staff members. The advisory board consists of representatives from industry, government, NGOs, the University of Dar-es-Salaam and TIRDO. The TCPC started in August 1995. The counterpart institution is the Danish Technical University (DTU).

In-plant assessments. Sixteen companies have now completed in-plant assessments and a further 16 are still on-going. The first assessments involved six companies from Dar-es-Salaam. Most of these companies are situated in a residential area, and the pollution they generate has been of concern to families living in the neighborhood and to the city of Dar-es-Salaam. When the Vice-President recently decided to take action against the polluting factories in these areas and went on an inspection round to close the worst cases, he was impressed by the results achieved by the assessments and has since emerged as a strong promoter of CP and the Centre. Ten companies from the islands of Zanzibar and Pemba participated in a second round of assessments. Although all in-plant assessments are ongoing, some companies have already made substantial savings. TCPC actively participated in the final workshop of the CEPITA project, a DANIDA-sponsored CP project. It is investigating how to best use the experience and results of the CEPITA project in follow-up activities. The centre has already decided to continue to help the companies in implementing the various options and in integrating CP into their management system. The TCPC successfully integrated health and safety aspects into its in-plant assessments. Now, the companies provide support to the Factories Inspectorate when they visit their factory to advise them on health and safety issues.

Training. Four CP training workshops have been conducted by the Centre for technical personnel from selected industries and stakeholders. Sixty-nine participants drawn from the 16 companies with completed assessments, factory inspectorate, city council, government and non-government organizations have been trained in the basic skills needed for conducting a CP assessment. Fifteen of these are now undergoing further training to qualify as CP consultants.

Information dissemination. The Centre conducted 2 awareness seminars and 1 dissemination seminar for about 120 chief executives and policy-makers drawn from selected industry and its associations, R&D institutions, government departments and organizations, environmental management agencies, NGOs, consultancy firms and media institutions. The Centre has also collected a number of CP publications in electronic and hard copies. It has distributed 1,000 copies of the Centre's CP Newsletter and 3000 copies of its brochure. The Centre has excellent connections to the press and has had extensive press coverage of its activities and of the concept of CP. The interviews which the Vice-President of Tanzania has given on CP in support of the centre have also been very helpful in supporting the concept in Tanzania.

Policy Dialogue. The centre has been very active in interacting with policy makers, industry executives and other stakeholders in the policy formation process. Because of this, the CP concept has been incorporated into the National Environmental Policy (draft) and the Sustainable Industrial Development Policy (1996 - 2000).

TUNISIA

Organizational structure. The Centre de Production Plus Propre Tunisien (CP3) was established with the help of the United States Agency for International Development in 1993. As from 1996, UNIDO/UNEP started supporting CP3. The Tunis International Centre for Environmental Technologies (CITET) is now about to establish a CP unit. CITET has an impressive range of activities needed to properly embody the CP concept into related issues. It is consequently a suitable host institution for an NCPC. The modalities of merging the efforts of CP3 with CITET are now being worked out. The counterpart institution for the NCPC in Tunisia is the World Cleaner Production Society of Norway. As CP3 has been active for nearly three years, it has built up an impressive record. Although the methods used are different from those used in the NCPC programme, the work can be described in similar terms.

In-plant assessments. Eleven in-plant assessments have been undertaken by experts from the United States supported by CP3. The experts used different methods and concentrated on no-cost and low-cost options. The new programme introduced a methodology for capacity building which focuses on training of factory personnel. In 1996 and the first part of 1997, CP3 carried out in-plant assessments in 6 textile dyeing and leather tanning companies. The World Cleaner Production Society will assist CITET and CP3 acting as a consultant to CITET. It is expected that 17 experts in CP will be trained and 15 in-plant assessments will take place starting in January 1998.

	Training. CP3 has conducted nine training activities, together with six awareness-raising seminars, attracting more than 650 industrialists, consultants, government officials and students. It participated in 15 seminars organized by other groups. CP3 also offers training modules on waste management and environmental impact assessment studies. An environmental action programme for hotels is being developed based on a UNEP document, introducing environmental management into day-to-day business. In 1997, CP3 was contracted by the NCPC programme to assist the NCPC in Mexico in preparing a marketing strategy and writing a business plan.
	Information dissemination. CP3 has published a booklet with CP success stories and prepared a CP catalogue describing the experience of CP in Tunisia. It has established a clearing house consisting of a library and an electronic information system. It also participated in May 1996 in the Meeting of the Commission on Sustainable Development and in the UNEP Mediterranean Regional Meeting.
	Policy Dialogue. CP 3 has been active in policy dialogue and CP components have been introduced in industrial modernization projects. Moreover, CITET decided to set up and support a cleaner production unit.

ZIMBABWE	***Organizational structure.*** The Cleaner Production Centre of Zimbabwe (CPCZ) is hosted by the Environmental Forum of Zimbabwe. The Forum is a group of Zimbabwean companies concerned about environmental degradation in Zimbabwe. The advisory board consists of members from the Confederation of Zimbabwe Industries, the Institute of Engineers, the Government, universities, the Standards Association of Zimbabwe (SAZ), the Forum, SIRDC and two companies. CPCZ began its activities in April 1995. DTI , Denmark, replaced IVAM, The Netherlands, as the counterpart institution providing technical advice on in-plant assessments. The Erasmus University of the Netherlands assists in education and policy activities.
	In-plant assessments. In 1996, CPCZ carried out 17 in-plant assessments in breweries, sugar-processing factories, foundries and coffee-making plants. Currently, the centre is carrying out in-plant assessments with the National Railways of Zimbabwe, and small municipality breweries. It charges substantial fees for its services. That the demand for CP assessments exists is indicated by the establishment of a new consulting company by a CP expert trained by the CPCZ. On the request of the CPCZ, the University of Zimbabwe completed an evaluation study of the CPCZ in-plant assessments.
	Training. Training of CP experts included two from SIRDC, one from the Ministry of Energy and five private consultants. The latter are available for the NCPC most of the time, while the rest are available only on a part-time basis. The contacts established with universities resulted in 3 seminars for lecturers and students. The 2 universities assigned 4 final-year engineering students for their final year projects to the CPCZ; they were involved in undertaking in-plant assessments. One master degree student was also under the supervision of the director of the CPCZ for his final thesis in 1997. A degree program is under development with the National University of Science and Technology (Bulawayo), while the University of Zimbabwe is initiating a master's course in engineering with CP inclusions in the syllabus.
	Information dissemination. A two-day workshop for central and local government authorities plus industrial associations drew many participants. This resulted in the request by participants for regional and tailor-made workshops for different groups; five workshops have since been conducted for local authorities including three for the directors of works of municipalities (Bulawayo, Gweru and Harare) followed by two workshops for councilors (politicians). The Centre has been invited to numerous workshops on pollution prevention, waste management, climate change (Geneva), and CP (Carl Duisberg Gesellschaft, Berlin). It has been asked by the Zimbabwe Broadcasting Corporation for help in preparing a programme on CP.
	Policy dialogue. In March 1996, a policy workshop was conducted for government officials. Together with the Government, CPCZ is developing a plan to integrate the concept of CP into government policy. In the future, emphasis will be put on the link between CP and policy at the municipal level.

CONTACT PERSONS AND ADDRESSES **ANNEX 1**

NATIONAL CLEANER PRODUCTION CENTRES

Carlos Adilio Maia do Nascimento, Director
National Cleaner Production Centre of Brazil
SENAI
Av. Assis Brasil 8450
Tel: + 555 13 478849 / 3400811
91140-000 Porto Alegre
Rio Grande do Sul, Brazil
Fax: + 555 13 478848
e-mail: ncpc@nutecnet.com.br

Ning Duan, Director
China National Cleaner Production Centre
Chinese Research Academy of Environmental Sciences
Anwai Beiyuan
Tel: + 86 10 649 01533 / 642 32255 or 233
Beijing 100012
People's Republic of China
Fax: + 86 10 649 01 532
e-mail: emicraes@public.east.cn.net

Vladimir Dobes, Director
Czech Cleaner Production Centre
Politickych Veznu 13
11000 Praha 1
Tel: + 420 2 260620
Czech Republic
Fax: + 420 2 260639
e-mail: czechcpc@czn.cz or
czechcpc@scretchy.czech.net

Sándor Kerekes, Director
National Cleaner Production Centre of Hungary
Budapest University of Economic Science
F_vám ter 8
Tel: +36 1 217 9588
Budapest
Hungary
Fax/Phone: +36 1 2188 076
e-mail: GKD_skerekes@pegasus.bke.hu

S. P. Chandak, Director
National Cleaner Production Centre of India
5-6 Institutional Area
Lodi Road, New Delhi 110 003
Tel: + 91 11 4611243 or 4625013
India
Fax: + 91 11 4625013 or 4615002
e-mail: ncpc@del2.vsnl.net.in

Guillermo Roman, Director
Centro Mexicano para la Producción Más Limpia
Avenida Politecnico s/n Edificio 9 de Laboratorios Pesados, Unidad Profesional Adolfo Lopez Mateos
Zacatenco, 007738 Mexico, D.F.
Tel: + 525 729 6201
Fax: + 525 729 6202
e-mail: cmpl@vmredipn.ipn.mx or cmpl@ipn9021.ipn.mx

Viera Feckova, Director
Slovak Cleaner Production Centre
Slovak Technical University
Pionierska 15, 83102 Bratislava
Slovak Republic
Tel: + 421 7 259 015
Fax: + 421 7 259 015
e-mail: feckova@cvt.stuba.sk or sccp@kchbi.chtf.stuba.sk

C. L. C. Migiro, Director
NCPC of Tanzania
Tanzania Industrial Research and Development Organization
P.O. Box 23235
Dar-es-Salaam
United Republic of Tanzania
Tel: + 255 51 668105 or 668979
Fax: + 255 51 668147
e-mail: cpct@udsm.ac.tz

Khalil Attia, General Manager
Centre International des Technologies de Environnement de Tunis
Boulevard de l'environnement
1080 Tunis
Tunisia
Tel: + 2161 770 285 or 770 998
Fax: +2161 772 255

Rachid Nafti, Director
Centre de Production Plus Propre
Colisée Soula, Escalier D, 2ème étage
2092 El Manar II
Tunisia
Tel: + 216 1 872 688
Fax: + 216 1 870 766
e-mail: cp3@cp3.com.tn

Lewin Mombemuriwo, Director
Zimbabwe Cleaner Production Centre
c/o UNIDO Office, 67-69 Union Avenue
P.O. Box BW 1635, Borrowdale
Harare, Zimbabwe
Tel: + 263 4 731778/9 or 792681
Fax: + 263 4 731779 or 723963
e-mail:cpczim@harare.iafrica.com

NCPC Programme Office at UNIDO

NCPC Programme
Environment and Energy Branch
Industrial Sectors and Environment Division
Vienna International Centre, P.O. Box 300
A-1400 Vienna, Austria

Tel. Switchboard: + 43 1 21131 0
E-mail: ncpc_env@unido.org
Fax: + 43 1 21131 6803
Home page: http://www.unido.org

Ralph Luken, Chief
Cleaner Industrial Production Unit
Tel: + 43 1 21131 3352
e-mail: rluken@unido.org

Igor Volodin
Programme Manager
Tel: + 43 1 21131 3938
e-mail: ivolodin@unido.org

Petra Schwager
Programme Officer, Latin America
Tel: + 43 1 21131 3749
e-mail: pschwager@unido.org

Nils Hogsted
Programme Officer, Asia and Africa
Tel: + 43 1 21131 5375
e-mail: nhogsted@unido.org

Paul Burgers
Assistant Programme Officer, Africa
Tel: +43 1 21131 0
e-mail: pburgers@unido.org

Elisabeth Slowiak
Finance
Tel: +43 1 21131 6732
E-mail: eslowiak@unido.org

Gertrude Hynek
NCPC Publications
Tel: +43 1 21131 3942
e-mail: ghynek@unido.org

Peter Pembleton
CP Information
Tel: +431 21131 3705
e-mail: ppembleton@unido.org

NCPC Programme Office at UNEP

UNEP Industry and Environment
Tour Mirabeau
39-43 Quai Andre Citroen
75739 Paris, CEDEX 15
France

Tel. Switchboard: + 33 1 4437 1450
E-mail: unepie@unep.fr
Fax: + 33 1 4437 1474
Home page: http://www.unepie.org

Jonathan Hobbs, Coordinator
Cleaner Production Programme
Tel: + 33 1 4437 1477
e-mail: jon.hobbs@unep.fr

Kristina Elvebakken, Environmental Affairs Officer
Cleaner Production Programme
Tel: + 33 1 44 37 3006
e-mail: kristina.elvebakken@unep.fr

Uno Abrahmsen, Advisor
Cleaner Production Programme
Tel: + 33 1 44 37 1422
e-mail: uno.abrahamsen@unep.fr

Garrette Clarke, Listserver
Cleaner Production Programme
Tel: + 33 1 44 37 1422
e-mail: garette.clarke@unep.fr

GENERAL INFORMATION ON CLEANER PRODUCTION AND THE NATIONAL CLEANER PRODUCTION CENTRES PROGRAMME **ANNEX 2**

What is Cleaner Production?

Cleaner Production (CP) is the continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase eco-efficiency and reduce the risks to humans and the environment. For processes, CP includes conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and toxicity of all emissions and wastes. For products, CP involves reducing the negative impacts along the life cycle of a product, from raw materials extraction to its ultimate disposal. For services, the strategy focuses on incorporating environmental concerns into designing and delivering services. Experience with CP shows that many improvements can be made in the production processes at no or very little cost, improving both the profitability and the environmental performance. The NCPC Programme aims to transfer this method of reducing resource utilization and discharge of pollutants in a cost-effective way.

The UNIDO/UNEP National Cleaner Production Centre Programme

The National Cleaner Production Centres (NCPC) programme is a joint initiative by the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme Industry and Environment Programme Activity Centre in Paris (UNEP IEPAC, hereafter referred to as UNEP). UNIDO is the executing agency, with UNEP assisting in the provision of strategic environmental guidance and professional support. UNIDO and UNEP meet regularly to review the progress of the NCPC programme.

Phase I of the NCPC programme started in 1994 with the start of eight national cleaner production centres. These eight centres are located in Brazil, China, Czech Republic, India, Mexico, Slovak Republic, United Republic of Tanzania and Zimbabwe. The eight centres were selected from solicitations received from 39 institutions in 25 countries. In 1996, Tunisia was included in the programme and in 1997, a centre was established in Hungary. Cleaner production projects, which are expected to lead to the establishment of NCPCs, have started in Uzbekistan, Croatia and Viet Nam.

The programme is funded from a number of sources. The Government of the Netherlands funds the centres in China, India, Zimbabwe, Tanzania and Mexico, and the Government of Austria funds the centres in the Czech Republic, Hungary and Slovakia. UNEP also provided substantial funding for the programme in Phase I. The centre in Brazil is funded through a self-financed trust fund. The centre in Tunisia, initially established with assistance from USAID, is supported by Norway. The cleaner production projects are funded by the Czech Republic (Croatia), Japan (Uzbekistan) and Sweden (Viet Nam).

Based on the lessons learned during Phase I, Phase II of the programme is now being started. It foresees increased regional expansions in India and China and the establishment of at least 10 additional NCPCs. Countries which are being given high priority include Croatia, Slovenia, Uzbekistan and Viet Nam, (where the cleaner production projects are expected to lead to the establishment of NCPCs) as well as Argentina, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Morocco, Philippines and Russia (where preparatory activities to establish an NCPC are on-going). Other countries are invited to submit or re-submit applications. It should be noted that the ultimate decision to establish centres will depend on funding from donor and/or recipient countries. The same solicitation procedure used for Phase I is being followed for Phase II. Evaluation missions and project planning workshops will be undertaken to select host organizations that will best house the centres.

Objectives of the National Cleaner Production Centres Programme

The ultimate goal of the NCPC programme is to increase the application of CP in industry and to incorporate the concept into national environmental policy. To realize this goal, the programme establishes NCPCs to facilitate the transfer of CP information and CP technology to industrial enterprises and environmental management agencies. This transfer of information and technology is not only north to south, but also south to south.

The Four Core Services of NCPCs

The centres provide four services: in-plant assessments, training, information dissemination, and policy dialogue. The four activities are interrelated and strongly support one another, as described below.

The organization of **in-plant assessments** is an important service that generates CP success stories. In-plant assessments can show how the CP concept works in the given country and also provide opportunities for hands-on training for plant personnel. The NCPC demonstration follows a method based on the PRISMA project, which has been successfully implemented in the Netherlands. The method proved to be suitable for small- and medium-sized companies during the UNIDO implemented DESIRE project (DEmonstration in Small Industries for Reducing wastE) in India. The results of in-plant assessments are profitable CP options that have been implemented and sustained.

The **training** service is linked to the in-plant assessments, as training of company staff and consultants takes place during these assessments. Training is also conducted outside the plants through workshops, seminars and in-depth technical training. These training activities are conducted to raise the CP capacity and awareness of branch organizations, government agencies, educational and research institutes, and consultants.

The **information dissemination** service is crucial in creating a CP network within a country and among countries. Within each country, the NCPC can provide technical information such as available technologies for solving environmental problems, share experiences with interested partners through the submission of case-studies, and promote the centre's activities. All centres are being connected to the Internet, which provides access to a wide variety of environmental information, including the UNIDO and UNEP home pages with information on CP (case studies, sectoral reviews and technologies), the NCPC Programme home page, and to e-mail. The centres have also been equipped with numerous UNEP and UNIDO technical manuals and policy guides on CP and environmental management, UNEP's diskette database on CP (International Cleaner Production Information Clearinghouse (ICPIC), and periodicals, which enable them to access and provide the most current information on CP. The NCPCs and support institutions are also connected by the e-mail conferencing network (NCPC-NET), which provides a platform for discussions and exchange of information.

Policy dialogue promotes effective policy frameworks which accommodate preventive environmental management. This not only involves administrative measures like licensing, but also economic instruments such as duty and fee systems for waste disposal and pricing of raw materials and energy. The NCPCs assess the existing policies and provide recommendations on how to better incorporate CP considerations. The centres have access to policy studies conducted in various countries and are supported by international institutions which have experience in conducting policy reviews.

Continuous Assistance through Counterpart Institution Arrangements

The programme has set up a pool of experienced institutions that can assist the NCPCs to achieve their objectives. These institutions, called counterparts, are contracted through the counterpart institution arrangement, which specifies activities to be performed by each counterpart to support the NCPC. The counterparts assist the NCPCs by sharing their experiences in promoting CP and by providing technical expertise to the centres in providing CP services.

The duration of the counterpart agreement is three years, in principle, to give the partners the opportunity to become familiar with each other and the overall NCPC programme. The counterpart institutions are also expected to assist in developing the programme methodology and the long-term strategy for each NCPC. The latter is especially difficult to guide as the considerable differences in the countries lead to significantly different strategies for each NCPC in the long term.

Currently, the counterpart institutions include the following organizations:

IVAM of the University of Amsterdam, and
the Erasmus University from the Netherlands,

STENUM of the University of Graz from Austria,
the Danish Technological Institute (DTI), and
the Technical University of Denmark (DTU) from Denmark,
the University of Massachusetts at Lowell from the USA, and
the World Cleaner Production Society from Norway (since 1996).

The above institutions have been selected as counterparts because of their significant practical experiences in CP and also with consideration to their status as professional organizations linked to development and educational institutions. The services are rendered on a cost-recovery rather than a commercial basis.

UNIDO and UNEP plan to engage NCPCs as counterpart institutes during Phase II of the programme as they have accumulated unique knowledge and experience in establishing centres. Currently, the NCPCs from the Czech Republic, India and Tunisia have been added to the pool of counterparts. These centres are also active in providing assistance to other projects on CP and environmental management. To monitor the progress of individual centres and the overall programme, the NCPCs and the counterparts work in close consultation with the staff of UNIDO and UNEP.

Annual NCPC meetings
The NCPC programme organizes annual meetings to evaluate the progress of the programme, to exchange experiences, and to discuss future activities to be undertaken by the centres. The First Annual Meeting of the National Cleaner Production Centres programme was held in Vienna, Austria, from 13 to 15 December 1995, with an excursion to the NCPC in Bratislava. The directors of the NCPCs, representatives of the counterpart institutions and donor countries, and UNIDO/UNEP personnel participated in the meeting.

The Second Annual Meeting of the National Cleaner Production Centres programme was held in Inyanga, Zimbabwe, from 25 to 30 November 1996. In addition to the programme review, short training sessions on total cost accounting, environmental management systems and ISO 14000, and business plan preparation were organized.

The Third Annual Meeting was held in Bangkok, Thailand, from 6 to 9 November 1997, and mainly discussed issues for entering Phase II of the NCPC programme (programme strategy and new project document). The meeting also included training sessions on marketing, business planning, integration of EMS and CP, and on-line CP information systems. The meeting was attended by the directors of the NCPCs, representatives from the international counterpart institutions, experts from the Swiss Government, GTZ and the Netherlands Management Cooperation Programme, representatives from UNIDO, UNEP and the Thailand Environment Institute.

Reports of the annual meetings are available upon request from UNIDO or UNEP.

Organizational Structure
The programme has a relatively lean organizational structure. Each NCPC is directed by an experienced country national, hosted within a local organization, and receives guidance from a national advisory board. Local host organizations provide infrastructure and a support mechanism to the centres' operations.

For successful capacity building, it is crucial to form partnerships with local organizations that are willing to invest resources for promoting CP. Host organizations make both financial and in-kind contributions to the centre, such as secondment of personnel, office facilities and equipment. This arrangement has been effective in building ownership of the activities in each country, and has also minimized operational costs.

The following institutions are currently hosting the NCPCs:

Brazil	Servicio Nacional de Aprendizage Industrial (National Industrial Training Association)
China	China Research Academy for Environmental Science
Czech Republic	Independent Non-Governmental Organization

Hungary	Budapest University of Economic Science
India	National Productivity Council
Mexico	Instituto Politecnico Nacional (National Polytechnic Institute)
Slovakia	Slovak Technical University
Tanzania	Tanzania Industrial Research and Development Organization
Tunisia	Tunis International Centre for Environmental Technologies
Zimbabwe	Environmental Forum of Zimbabwe

A Modality of Operation has been signed by each host institution and UNIDO to specify inputs to be provided by UNIDO/UNEP and the host organization, and activities to be undertaken by the NCPC.

Each NCPC establishes an advisory board to obtain guidance on the centre's activities and to get support for its operations. The advisory board solicits representation from the most important "CP players" in the country, such as representatives from industrial organizations, Ministries of Industry, Environment, and Economy, as well as from education and research institutions. The NCPC director and local UNIDO/UNEP representatives are included. Individual companies are also represented occasionally.

The average total annual budget provided to each NCPC is approximately US$ 200,000. Each director has an annual discretionary budget of approximately US$ 40,000 - which is allocated for national consultants and other expenses. UNIDO administers the remainder of the budget, in consultation with the centres, to recruit counterpart institution staff as well as other international experts.

UNIDO's Cleaner Production Unit, within the Environment and Energy Branch, is responsible for programme administration, development, monitoring and fund raising. The Cleaner Production Programme of UNEP is responsible for the UNEP contribution of the NCPC Programme, such as information, networking and policy advice.

First Year Evaluation

An independent evaluation of the NCPC Programme was commissioned at the end of 1995. The evaluation report recommended adjustments and improvements for Phase II of the programme. It also recognized the relevance of the NCPC Programme and its unique potential role in the eco-efficient industrial development of the targeted countries. The report concluded the following:

> *" . . . it must be recognized that the UNIDO/UNEP programme design provides a unique set-up in terms of offering a profound infrastructure for international co-operation and networking between CP-actors throughout the world, which bilateral programmes cannot provide."*

Lessons Learned

With the first two years of the programme completed, many issues and ideas on how to improve the NCPC programme have been identified through the annual meetings, independent evaluations and daily operations. The following summarizes some of the lessons learned so far:

A five-year project period is necessary to develop an NCPC to function as a catalyst and a service-oriented unit.

People trained in CP need to be recognized for their specialist abilities. UNIDO and UNEP are testing the Cleaner Production Best Practice Guide of the Organization for Economic Cooperation and Development (OECD) in Tunisia, to see if it can form the basis for a system for the certification of CP experts.

The CP message needs to be incorporated into and promoted with emerging issues of interest, such as Environmental Management Systems and ISO 14001. Certification should not be the only goal of introducing EMS and ISO 14001. The main goal should be improved environmental performance. With CP, NCPCs can work with enterprises to introduce continual improvement that achieves environmental goals and economic efficiency. Additional work needs to be done to clarify the relationship between EMS and CP, and to train the NCPCs. This research is underway at UNEP and UNIDO.

Sector-specific technical expertise should be developed. The NCPCs are centres of excellence in CP and its applications. While the methodology is applicable to all industrial sectors, there are limits on the ability of companies and, to some extent the CP experts, to identify technical opportunities. To respond to this need, the programme is developing projects that combine the methodological CP approach with sector specific expertise.

The possibility of working with other environmental services, including end-of-pipe solutions, needs to be considered to provide a comprehensive solution to achieve compliance, even though CP should clearly remain the preferred strategy. While CP enables a company to reduce its pollution load in a cost-effective manner, in some cases standards can only be met by combining CP and end-of-pipe treatment. This is more relevant if legislation is based predominantly on the command-and-control approach.

Networking and programme interaction can help in building mutually supportive mechanisms. Although national circumstances differ, many challenges and solutions for CP are universal. The annual meetings and information networking have helped in providing a platform for centre personnel to learn from each other's experiences and to avoid duplication of efforts. Additional efforts will be made to share the NCPC experiences with other CP practitioners outside the NCPC network and to catalyze the establishment of NCPC-like programmes.

Emphasis should fall on enhancing capacity to ensure local ownership and continuity beyond donor dependence. Cost and responsibility sharing make each NCPC a multi-stakeholder institution. There is a need to consult both the demand side (i.e. industry) and the supply side (i.e. donors and governments) to ensure that the local capacity developed adequately addresses the needs and demands within the country.

An integrated programme, rather than project approach needs to be used for sustainable CP implementation. The NCPCs need to include in their plans of action both the micro level (in-plant assessments) and macro level (policy advice) to make CP sustainable within a country.

UNIDO and UNEP developed a strategy which incorporates those lessons learned to improve the services of the NCPC programme. In this connection, a strategy document has been prepared.

SELECTION OF PUBLICATIONS **ANNEX 3**

Technical manuals and reports on:
Breweries, dairy, electronics, fertilizers, hotels, iron foundries, leather tanning, metal finishing, non-ferrous metals ore mining, nickel, pulp and paper, sugar refineries, textiles (UNIDO and UNEP).

Other manuals and reports on:
Strategies and policy for CP, environmental auditing, hazardous wastes, emission reduction, chemical accidents, transport, environmental compliance, life-cycle assessment, eco-designs (UNIDO and UNEP).

Training and Information:

Cleaner Production - A Training Resource Package (Trainers Handbook), UNEP, 1996
Trainers Workbooks in brewing, leather and textile wet processing, UNEP, 1996
International Cleaner Production Information Clearinghouse, Diskette, Version II, UNEP, 1996
Trade Implications of International Standards for Quality and Environmental Management Systems, Survey Results, UNIDO/ISO, 1996
DESIRE - "From Waste to Profits" - the Indian Experience: Case Studies, Methodology for Waste Minimization, Video, UNIDO, 1995
Environmental Action Pack for Hotels, IHA/IHEI/UNEP, 1995
ESID: "Ecologically Sustainable Industrial Development", 10 learning units, 7 short films on video, diskettes with data base, case studies and project document sample, 3 booklets, learning recall tape, UNIDO, 1994

Case Studies:

NCPC Programme Case Studies, UNIDO/UNEP, 1997
Cleaner Industrial Production, Demonstration Projects, UNIDO, 1995
Cleaner Production Worldwide, Volume I, 1993, and Volume II, 1996, UNEP
Cleaner Production in the APEC Region, UNEP, 1994

Periodicals:

Industry and Environment Review (quarterly) with CP Newsletter (bi-annually) as a supplement, UNEP IE
Sustainable Industrial Development Network Newsletter (annually), UNIDO

Videos: (*)

"Sustainable Industrial Development", 10 min/English, French and Spanish under preparation, UNIDO, 1997
"Cleaner Production: - A Global Trend", 14 min/English/German, French and Spanish under preparation, UNIDO, 1996
"National Cleaner Production Centres", 9 min/English and Spanish, UNIDO, 1996
"Ganancias sin Residuos", 14 min/Spanish, UNIDO, 1996
"From Waste to Profits - the Indian Experience", 10 min/English, UNIDO, 1996

(*) All videos available in VHS. Please specify colour system (PAL, SECAM or NTSC).

PART V: OFFICIAL DOCUMENTS OF THE COMMISSION ON SUSTAINABLE DEVELOPMENT RELATING TO TECHNOLOGY

Economic and Social Council
Commission on Sustainable Development
Sixth session
20 April-1 May 1998

E/CN.17/1998/6
Dist: General
5 March 1998

Original: English

Capacity-building, education and public awareness, science and transfer of environmentally sound technology
(Chapters 34 - 37 of Agenda 21)

Report of the Secretary-General*

V. Transfer of environmentally sound technology: chapter 34 of Agenda 21

Contents

I. Introduction

1. The present report consists of brief summary reports prepared on four separate chapters of Agenda 21 by their respective task managers.[1] It has been prepared in response to the decision of the General Assembly at its nineteenth special session, in 1997, to include, in the multi-year programme of work of the Commission on Sustainable Development, capacity-building, education and awareness-raising, science, and transfer of technology as a cross-sectoral theme for consideration by the Commission in 1998. Each section of the report provides a brief status update and a series of proposals for further action. In addition, more detailed information is provided as addenda to the present report and in background papers made available by the task managers. This additional information is referred to in the relevant section of the report.

* This extract from the Secretary-General's report includes only the technology-related portion. For the chapters on capacity-building, education and public awareness, and science, see the full document E/CN.17/1998/6.

V. Transfer of environmentally sound technology: chapter 34 of Agenda 21*

A. Technology transfer and sustainable development

46. Technology is critical to economic growth and sustainable development. The development and dissemination of new and improved technologies contributes to the increased production and introduction of goods and services, and to production processes that are more resource efficient and less polluting. In general, however, increases in the volume of production and consumption are outpacing the introduction of cleaner technologies, contributing to continued deterioration of the global environment.

47. Sustainable development requires accelerated development, transfer and dissemination of both cleaner technologies for existing production and consumption patterns, and innovative technologies that meet people's needs in new and more sustainable ways. In particular, sustainable development on a global basis requires accelerated transfer of environmentally sound technologies from developed to developing countries.

48. While business and industry play a crucial role as responsible entrepreneurs in the development and transfer of environmentally sound technologies, Governments still have a major role to play in setting the policy framework and providing incentives for business and industry to contribute to sustainable development on a global basis. Making eco-efficiency a management objective in business planning and operations is an important step towards sustainable development and may require substantial changes in business strategies. In order to promote improvements in eco-efficiency, there is a need for further development of measurement methods, environmental performance indicators and technology benchmarking, including the assessment and adoption of new and cleaner technologies.[2]

49. Government policies need to be based on a thorough understanding of the factors influencing companies' environmental and economic performance, including their adoption of best practices in environmental management and use of environmentally sound technologies in production processes.

50. Small and medium-sized enterprises, in particular, have come under pressure from consumers, client enterprises and environmental regulations to improve environmental performance, but often have difficulties meeting these requirements. Small- and medium-sized enterprises should be supported by national and local authorities and should have access to consultants and researchers who can assist in applying eco-efficiency in business strategies, planning and operations. Networks of organizations and experts that can assist small and medium-sized enterprises need to be established. The European Roundtable on Cleaner Production is a step towards creating such a network in Europe, and similar initiatives should be undertaken in other regions.

51. Cooperative arrangements among chambers of commerce and other business and industry organizations in developed and developing countries could help in spreading best practices, including training in technical skills and know-how, management practices and the use of new management tools, and institutional cooperation. Programmes such as Asia EcoBest, developed by the Regional Institute for Environmental Technology in Singapore is an example of successful cooperation.

* For more detailed information, see document E/CN.17/1998/6/Add.1 .

B. Policies for promoting the transfer of environmentally sound technologies

1. Strengthening technology cooperation

52. The Technology Cooperation Workshop, organized by the United Kingdom of Great Britain and Northern Ireland under the auspices of the Advisory Committee on Business and the Environment,[3] suggested that there is a need for the development of guidelines or codes of practice for Governments on technology cooperation. Such guidelines or codes of practice should identify, based on existing experience and emerging opportunities, areas for government policy interventions to promote technology partnership initiatives between economic actors in developed and developing countries and to remove obstacles to such initiatives. There is a need to identify the potential actors, including Governments, business and industry, research and development institutions and technology centres, and to examine their respective roles, specific interests and priorities in technology partnership initiatives.

53. Technology partnership initiatives should take into account economic opportunities and the capacities of the developing country partners for technology integration, management and dissemination. They should be designed to include the transfer and adaptation of specific production technologies, long-term capacity-building and cooperation in further research and development. The economic, environmental and cultural context of the partners from developing countries should be considered in selecting the technologies to be transferred.

54. There is a need for further study of the effectiveness of various incentives and economic instruments for attracting the participation of private sector companies from developed countries in technology partnership initiatives with developing country partners.

55. Finally, mechanisms and tools must be developed to monitor and measure the effectiveness of technology partnership initiatives for achieving specific economic, social and environmental goals and targets as defined by the partners.

2. Increasing the transfer and dissemination of environmentally sound technologies resulting from publicly funded research activities*

56. The International Expert Meeting on the Role of Publicly-funded Research and Publicly-owned Technologies in the Transfer and Diffusion of Environmentally Sound Technologies, organized by the Republic of Korea, concluded that Governments can play a considerable role in the establishment of an institutional framework within which the identification, assessment, transfer, adaptation and post-transfer follow-up of environmentally sound technologies can take place, in particular in the case of environmentally sound technologies resulting from publicly funded research activities. Building and strengthening cooperation between information systems, national cleaner production centres, centres for innovation and enterprise development, and other intermediaries would be a necessary step in establishing such a framework.

57. The Expert Meeting also concluded that the transfer and dissemination of publicly funded environmentally sound technologies generally takes place through existing technology transfer mechanisms, including intra-enterprise transfers (direct investment), joint ventures, environmentally sound technology licensing arrangements, and agreements between developing and developed country enterprises or research institutions to jointly develop and commercialize environmentally sound technologies.

---

* This section is based on the report of the International Expert Meeting on the Role of Publicly-funded Research and Publicly-owned Technologies in the Transfer and Diffusion of Environmentally Sound Technologies, Kyongju, Republic of Korea, 4 - 6 February 1998 (see E/CN.17/1998/12) .

58. Moreover, many technological innovations, including most of those that result from publicly funded research activities, are not patented or commercialized by their developers, but are published in technical literature. This knowledge is freely available for commercialization by enterprises with the necessary capacity.

59. Based on the work of the Expert Meeting, the policy options set out below might be considered by the Commission on Sustainable Development for further action.

60. Governments of developed countries should provide incentives to accelerate the transfer and dissemination of publicly funded environmentally sound technologies to developing countries, including tax incentives, promotion of environmentally sound technology-related imports, and technology transfer in exchange for intellectual property protection.

61. Governments, with the support of international organizations and financial institutions, should support small- and medium-sized enterprises, including through funding of feasibility studies on market opportunities and commercial viability of environmentally sound technologies, fiscal incentives such as lower taxes or tax holidays, export promotion programmes such as trade missions targeted towards environmentally sound technologies, and assistance in the development of business plans.

62. Business risks for environmental enterprises should be reduced, for example through various types of financial assistance such as grants, venture capital investments underwritten by Governments and loan guarantee schemes.

63. Governments and international organizations should support and encourage pilot and demonstration projects related to the use of environmentally sound technologies in developing countries.

64. Governments, with the support of international organizations, should develop new mechanisms for the sharing and exchange of environmentally sound technologies, such as bilateral and multilateral memoranda of understanding and environmentally sound technology pooling or banks. Further studies of mechanisms for improving the dissemination of environmentally sound technologies should be encouraged.

65. Governments should promote the transfer to developing countries of non-patented or uncommercialized technologies resulting from publicly funded research activities, including through technology cooperation. Transfer of such knowledge can contribute to capacity-building in developing countries as well as to the use of these results.

66. Governments should promote joint research and development activities between institutions in developed and developing countries in order to strengthen capacity-building and training, and encourage the sharing of the results of joint research and development activities, including joint patenting.

3. Developing national technology strategies

67. National strategies for technological development are an important element of development strategies. They should be targeted towards strengthening national technological research and development capacities and improving the capacity for technology transfer, integration and dissemination.

68. Governments of developing countries should be encouraged and supported in their efforts to focus technology strategies on industries that are particularly important with respect to economic growth, natural resource consumption and environmental pollution. The objective should be to identify areas where a country's development "opportunities" match its national "capacities" for technology innovation, integration and dissemination, and areas where technology cooperation is needed to bridge the gap between "opportunities" and "capacities". In defining a technology development strategy, it is important to take into account the different interests and capacities of various stakeholders.

69. Regional expert group meetings, jointly organized by Governments and United Nations agencies, can be a useful mechanism to develop guidelines or manuals, as tools for the development of technology strategies. The guidelines for national technology needs assessment adopted by the Commission on Sustainable Development in 1996 may be useful in developing such guidelines or manuals.

NOTES:

1 The task managers for chapters 34 - 37 of Agenda 21 are as follows: the Department of Economic and Social Affairs of the United Nations Secretariat for chapter 34 (Transfer of environmentally sound technology, cooperation and capacity-building); the United Nations Educational, Scientific and Cultural Organization for Chapters 35 (Science for sustainable development) and 36 (Promoting education, public awareness and training); and the United Nations Development Programme for chapter 37 (National mechanisms and international cooperation for capacity-building in developing countries).

2 See the Chairman's summary of the Roundtable on Business and Sustainability, hosted by the European Partners for the Environment under the patronage of the European Council and the Commission of the European Communities (Brussels, 11 February 1998).

3 See the summary report of the Technology Cooperation Workshop, held by the United Kingdom of Great Britain and Northern Ireland under the auspices of the Advisory Committee on Business and the Environment (London, 10 December 1997).

Economic and Social Council
Commission on Sustainable Development
Sixth session
20 April-1 May 1998

E/CN.17/1998/6/Add.1
Distr.: General
11 March 1998

Original: English

Capacity-building, education and public awareness, science and transfer of environmentally sound technology

Report of the Secretary-General

Addendum

Areas for policy action by Governments to accelerate the development, transfer and dissemination of environmentally sound technologies

Chapter 34 of Agenda 21

Contents

Chapter

I. Introduction

1. The present report supplements the information contained in section V (Transfer of environmentally sound technologies) of document E/CN.17/1998/6, and suggests areas for future action by Governments.

2. The report is based in part on the reports of the Expert Meeting on the Role of Publicly-funded Research in the Transfer and Diffusion of Environmentally Sound Technologies, organized by the Republic of Korea (Kyongju, 4-6 February 1998); the Technology Cooperation Workshop, held by the United Kingdom of Great Britain and Northern Ireland under the auspices of the Advisory Committee on Business and the Environment (London, 10 December 1997; and the European Roundtable on Business and Sustainability, hosted by the European Partners for the Environment under the patronage of the European Council and the Commission of the European Communities (Brussels, 11 February 1998).

II. Trends related to the development, transfer and dissemination of environmentally sound technologies[1]

3. Since existing production and consumption levels are already responsible for environmental stress in many areas, the accelerated development and application of new technologies that could bring about considerable improvement in energy and material efficiency will be required to ensure sustainable development.

4. In order for companies to remain competitive and to meet increasingly stringent environmental standards, they will need to move towards greater eco-efficiency and cleaner production. The "trendsetters" will need to be companies in developed countries that have the resources and capacities to invest in best practices in environmental management and environmentally sound technologies. Emerging global standards for environmental management systems (for example, the Eco-Management and Audit Scheme (EMAS) and ISO 14000) have created strong incentives for this move to eco-efficiency and cleaner production.

5. Information and communication technology (ITC) is at the forefront of technological advances in environmental protection (environmental monitoring, risk control, management systems, simulation and so forth). ITC is also a means to spread best practices. The use of ITC for environmental protection, exchange of experience, information access and technology transfer is becoming an important success factor in efforts towards sustainable development.[2]

6. While necessary, the use of regulatory regimes alone is no longer regarded as sufficient to stimulate the adoption of environmentally sound technologies by companies. Increased emphasis is being put on a wider use of market-based instruments and voluntary approaches, including the adoption of environmental management systems, giving industry the choice of the means to achieve the goals and targets established by Governments, while providing the incentives for companies to innovate.[3]

7. Small and medium-sized enterprises (SMEs), especially in developing countries, have particular difficulties in adopting environmentally sound technologies and management systems, due to limitations in technological capacity, access to finance and information. As a result, SMEs often produce disproportionate amounts of industrial waste and pollution. Policies and programmes to promote sustainable development should include particular support to SMEs to enable them to acquire, use and manage environmentally sound technologies.

III. Areas for future action by Governments

A. Strengthening technology cooperation

8. Technology transfer to developing countries has an important role to play in achieving sustainable development objectives on a global scale. It stands the best chance of success when it builds upon partnership arrangements involving public and private sector actors from developed and developing countries. Cornerstones are shared responsibility, clear commitments, achievable targets, recognition of mutual benefits, building of confidence and dealing with cultural differences in a sensitive and positive way.

9. Partnerships use different mechanisms to transfer and disseminate environmentally sound technologies, such as joint ventures, direct investment, sourcing agreements, co-production arrangements, licensing, and strategic alliances between firms and R&D institutions. Training in management and technical skills and know-how should be part of technology partnerships. Intermediaries could help in these activities.

10. Technology cooperation should consider the legal and political factors, institutional structures and social norms within which cooperative arrangements are implemented. Where companies conduct business in developing countries, they have a responsibility to ensure that the social dimension of their activities is also sustainable. It is important in this respect to involve, at an early stage, all relevant stakeholders in a multi-stake-holder dialogue.

European Union programme supports small- and medium-sized enterprises

BOX 1

The European Union Structural Funds Programme (1994-1999) is providing 1 billion ECU for small and medium-sized enterprises, channelled through grants to member States and aimed at developing clean technologies and clean production within highly competitive markets.

Source: "1997 Guidelines on national reporting", Part V, "Guidelines on Technology", submitted by the Commission of the European Communities to the Commission on Sustainable Development at its present session.

Disseminating best practices in business and industry

BOX 2

The European network, PREPARE, represents a group of cleaner production experts from industry, research and government from 18 countries. Its activities include the exchange of information on cleaner production technologies and cleaner production development (eco-design), the evaluation of results of cleaner production efforts as well as the stimulation of industry-oriented R&D projects. Currently, PREPARE is launching thematic networks in the field of cleaner production. One of the networks aims at disseminating environmental best practices in small and medium-sized enterprises in Europe.

Source: PREPARE secretariat.

1. Mechanisms for the transfer of environmentally sound technologies

11. Perhaps the simplest technology transfer process, making the least demand on technological capacity in the recipient country, is an intra-enterprise transfer, through direct investment. The parent enterprise located in a developed country provides the equipment, management structure, practical experience, training and often connections to export markets to its subsidiary located in a developing country. There is evidence, however, that the technology and practices transferred through direct investment, find limited dissemination to other enterprises or sectors of the recipient developing country. Governments could promote such transfers through financial incentives to enterprises, including tax incentives and investment guarantees.

12. Another mechanism is joint ventures between enterprises of developed and developing countries, either
with or without licensing or other direct payment for the technology. Experience indicates that joint ventures tend to be more effective in disseminating new technologies, but require a relatively high level of commitment on both sides and well-developed capacities in the recipient enterprise for technology adaptation, use and management. In addition to the use of tax and investment incentives, Governments could promote joint ventures for the transfer of environmentally sound technologies by facilitating contacts between enterprises in developed and developing countries. Governments could also finance or otherwise support the dissemination of information on technologies and enterprises, participation in trade fairs, visits between enterprises, and contacts through government channels.

Driving environmental business in Asia

BOX 3

The Commission of the European Communities and Singapore jointly established the Regional Institute for Environmental Technology (RIET) in Singapore to promote the transfer and exchange of environmental know-how and services between Europe and Asia. RIET's network contains many leading suppliers of environmental technologies and management companies from Europe and the Asia and Pacific region. To serve suppliers, RIET opened the door to over 4,000 customers in the region through market information, client-centred research, and business development support. Driving demand, RIET each year helps several hundred Asian companies address environmental problems through environmental management support and project or equipment brokerage. During the period 1997-2002, the European Community reserved 8 million ECU for the Asia EcoBest project to promote European environmental best practices in Asia.

Source: "Europe-Asia co-operation strategy in the field of environment" (COM (97) 490 - Final), communication from the Commission of the European Community to the European Council, the European Parliament and the Economic and Social Committee.

13. Where developing country enterprises or institutions have research and development capabilities in a particular area of technology, they could opt for entering into agreements with enterprises or institutions of developed countries to jointly develop and commercialize environmentally sound technologies. Such agreements require a high level of technological capability and the willingness to undertake relatively high-risk investments, but have the advantage of shared benefits resulting from the commercialization of the technology jointly developed, including joint patenting or licensing.

14. Licensing arrangements between enterprises in developed and developing countries is another mechanism
to transfer technology. Licensing arrangements could involve partnerships or strategic alliances with the source enterprise, through supply agreements or cooperation in local or regional marketing. The recipient party may also use third-party assistance for the development of the capacity to commercialize technology. Governments could assist such licensing arrangements, through, for example, financial assistance for licensing costs and assistance in training and capacity-building of the recipient enterprise in the developing country.

2. Promoting technology cooperation between developed and developing countries

15. Governments, enterprises, R&D institutions and intermediaries concerned with technology development,
transfer and dissemination are increasingly working together to accelerate the application of research results to commercial production. Different forms of technology cooperation are being created to combine the resources and capacities of the various partners in research, development, commercialization, adaptation, dissemination and further innovation. To date, this cooperation has been largely limited to developed countries. There is a need to extend them to include partners from developing countries.

16. Based on the work of the Technology Cooperation Workshop, organized by the United Kingdom under the auspices of the Advisory Committee on Business and the Environment, the following conclusions may be drawn.[4]

17. There is no single model for technology cooperation. Flexibility is essential to match the needs and capacities of technology users with market opportunities and the interests of technology suppliers. Supply

and demand are interactive processes. Suitable technological solutions are often the result of merging high-tech industrial know-how, which is in the hands of technology suppliers in the developed countries, with low-tech indigenous knowledge existing on the side of the users in the developing country.

18. Successful technology cooperation often seems to be related to the application of technologies with a proven track record. This reduces the risk for the recipient and reassures providers of finance as to cost-effectiveness and predictability -- especially for public sector authorities who tend to be more cautious than potential private sector backers. Technologies with a proven track record may also be helpful in securing the support of local communities whose commitment is often a vital ingredient. However, at least some adaptation to local circumstances is almost always required, reinforcing the advantages of working with partners with local knowledge and experience and staying close to existing and potential customers.

BOX 4

United Kingdom Technology Partnership Initiative (TPI) has been successful

Since it was launched in 1993, TPI has made progress in developing a network of potential users of environmental technology and services. By the end of 1997, the number of network members had risen to nearly 6,000. It has gained international recognition in that TPI was one of the first to define the critical components for disseminating information about technology transfer. Although experience suggested that the basic components of TPI are right, adjustments are necessary in its strategy at the time of its renewal in April 1999, so as to achieve more hands-on, in-depth cooperation with key decision makers in participating developing and industrializing countries.

Source: TPI secretariat, Joint Environmental Market Unit, Department of Trade and Industry and Environment of the United Kingdom of Great Britain and Northern Ireland.

19. Recipient companies or Governments sometimes lack trust in low-tech solutions. Other obstacles may relate to cultural factors, differences in business practices and structures, suspicions of "foreign" technology or technology with an unproven track record, or the discounting of technology unless it was seen as new or "fashionable". Pilot and demonstration projects are useful to overcome these and other obstacles and to demonstrate the viability of certain technologies under local circumstances.

20. There is, in principle, no shortage of information about technology needs or the range of available technologies. There are, however, problems regarding the availability of the "right" information reaching the right people in the right form. Developed country Governments and industry trade associations could do more to help their existing and potential technology suppliers, especially SMEs, with information on opportunities and requirements for technology transfer to developing countries, and encourage contacts with potential partners through missions and other networking activities. Developed countries could also support developing countries in undertaking technology needs assessment projects. A sectoral approach in both these areas appears to be most effective.

21. Official Development Assistance (ODA) should support and leverage assistance for management training and other programmes for capacity-building on the side of existing and potential technology users in developing countries. Intermediaries, including private and public sector consultancy services, information systems, technology centres and centres for enterprise development, should be used and further encouraged to undertake such activities.

B. Increasing the transfer and dissemination of environmentally sound technologies resulting from publicly funded research

22. In response to a specific recommendation in the Programme for the Further Implementation of Agenda 21,[5] the Republic of Korea sponsored a project on the role of publicly-funded research and publicly owned technologies in the transfer and diffusion of environmentally sound technologies. The project was jointly implemented by the United Nations Conference on Trade and Development, the Department of Economic and Social Affairs of the United Nations Secretariat and the United Nations Environment Programme. For the project, a number of country case studies and studies on selected policy, legal and institutional issues were carried out. The results of these studies were presented to an expert group meeting, organized by the Republic of Korea.[6]

23. The meeting concluded that public funding remains a major source for R&D activities and is particularly vital for R&D on environmentally sound technologies. Many Governments, especially of developed countries, have allocated considerable funds to finance or co-finance research activities for the development of new technologies, including environmentally sound technologies. A strong interest of developed country Governments in funding research on environmentally sound technologies is to strengthen the international competitiveness of their industries and to facilitate companies' compliance with environmental regulations. A growing share of government R&D funding is being allocated to private sector research to develop new technologies.

24. The meeting noted that many Governments explicitly refer in their public policy statements to the need to share environmentally sound technologies with the developing world. It appeared, however, that the extent and pace at which environmentally sound technologies were being transferred to developing countries were inadequate. New policy initiatives are required to accelerate the transfer of publicly funded environmentally sound technologies to users in developing countries and to facilitate the dissemination of such technologies in those countries. Technical cooperation and ODA should assist in the transfer of environmentally sound technologies resulting from publicly funded research by supporting developing countries in the development of the capacities to assess, adapt, use and manage environmentally sound technologies. Environmental auditing services could help in identifying priorities for technology transfer.

Photovoltaics in developing countries **BOX 5**

The World Bank and the International Finance Corporation (IFC), with planned assistance from the Global Environment Facility (GEF), are developing a Solar Development Corporation (SDC) and a Photovoltaics Market Transformation Initiative (PVMTI). Both SDC and PVMTI should be launched shortly after an extended period of market research. The $ 30 million, GEF - funded PVMTI will make multiple investments from $ 500,000 to $5 million in existing and new consortiums in India, Morocco and Kenya that can offer innovative packages and applications for both on- and off-grid PV power.

Source: Financial Times (1 October 1997), p. 11.

25. Many environmentally sound technologies exist in the public domain that remain underutilized or unutilized. To make these technologies accessible to developing countries, a number of measures could be taken. For example, information on available environmentally sound technologies could be systematically compiled and made available through existing databases. Incentives could also be introduced to encourage technology suppliers to facilitate access of potential users in developing countries to the technologies, to assess user needs and to assist in technology adaptation.

26. Governments play an important role in building and strengthening strategic alliances for the generation,
commercialization and dissemination of environmentally sound technologies that are the result of publicly funded research activities. Incentives should be provided to local R&D institutions to increase the output of marketable R&D results on environmentally sound technologies. Intermediate mechanisms need to be created and strengthened that would work directly with firms and other end-users of technology. Many intermediate steps must be undertaken before the knowledge generated in R&D institutions can be used by potential end-users of technology. Such intermediary steps include the further development of the technology, pilot phases and demonstration projects. Moreover, intermediaries are often essential to find commercialization partners for R&D institutions and to provide follow-up services to firms.

University Partnership for Knowledge Sharing **BOX 6**

The Cooperation Programme in Europe for Research on Nature and Industry through Coordinated University Studies (COPERNICUS) represents an effort to mobilize the resources of European universities committed to sustainable development and environmental management. COPERNICUS functions as a networking tool for cooperation between universities in Europe to share knowledge and expertise and be a partner for industry and governmental authorities at the local level.

Source: COPERNICUS secretariat, Institute of Environmental Research, University of Dortmund, Germany.

C. Developing national technology strategies

27. Developing countries should develop policies to enhance the ability of their companies to compete in an
increasingly competitive world economy. Technological development is essential to that process, and developing countries should harness their technological and entrepreneurial resources to that end.

28. The relationship between technological progress and economic performance is well established. Knowledge and new ideas are the primary source of economic growth because, together with an enabling business environment that rewards entrepreneurial innovation, they lead to technological innovation and hence to productivity improvements. If not enough resources are dedicated to scientific research and technological development, the rate of economic growth will suffer. Domestic R&D capacities are the basis not only for technology generation, but also for acquiring technological know-how from abroad, and ensuring that it can be exploited domestically.[7]

29. Most developing countries have inadequate levels of human resources, industrial capacity and infrastructure. In developing national technology strategies, developing countries should concentrate on improving the productivity of domestic companies in economic sectors in which comparative advantage and technological capacities best match.

30. Policies should be designed to strengthen technological innovation and adaptation capabilities. Strong technological capacities within research institutions and universities should be complemented by mechanisms to make them sensitive to the signals of the marketplace. Policy measures should target the building of institutional networks involving R&D institutions, companies and intermediaries to ensure rapid commercialization and adaptation of technological knowledge and know-how both from domestic and foreign sources.

NOTES:

1 In the context of the present report, environmentally sound technology is used as a relative concept. What might be perceived as environmentally sound today may not necessarily be so tomorrow. Moreover, any technology must be viewed in relation to the socio-economic and cultural conditions in which it is operating. A narrow definition of environmentally sound technologies seems to be neither helpful nor desirable. Discussion on this issue may benefit from a categorization of environmentally sound technologies, as attempted by the United Nations Environment Programme.

2 See "Europe-Asia co-operation strategy in the field of environment" (COM (97) 490 - Final) communication from the Commission of the European Communities to the European Council, the European Parliament and the Economic and Social Committee.

3 See the Chairman's summary of the Roundtable on Business and Sustainability, hosted by the European Partners for the Environment under the patronage of the European Council and the Commission of the European Communities (Brussels, 11 February 1998).

4 See the summary report of the Technology Cooperation Workshop, held by the United Kingdom under the auspices of the Advisory Committee on Business and the Environment (London, 10 December 1997).

5 General Assembly resolution S-19/2, annex, para.91.

6 For the report of the International Expert Meeting on the Role of Publicly funded Research and Publicly owned Technologies in the Transfer and Diffusion of Environmentally Sound Technologies (Kyongju, Republic of Korea, 4-6 February 1998), see document E/CN.17/1998/12.

7 Michael Borrus and Jan Stowsky, Technology Policy and Economic Growth, BRIE Working Paper No. 97 (Berkeley, California, University of California at Berkeley, April 1997), p. 2.

United Nations
Economic and Social Council
Commission on Sustainable Development

E/1998/29
E/CN.17/1998/20

Report on the Sixth Session*

(New York, 22 December 1997 and 20 April 1 May 1998)

(Elements relating to technology and industry)

Chapter

* This is an extract from the report of the Commission on Sustainable Development on its sixth session containing the elements relating to the themes of technology and industry.

Chapter I

Matters calling for action by the Economic and Social Council
or brought to its attention

B. Matters brought to the attention of the Council

2. The attention of the Council is drawn to the following decisions adopted by the Commission:

Decision 6/2: Industry and sustainable development:[1]

1. The Commission on Sustainable Development reaffirmed that in order to achieve sustainable development, Governments, in cooperation with non-State actors, need to undertake greater efforts to integrate economic, social and environmental goals into industrial policy and decision-making. Towards this end, Governments need to expand and intensify cooperation with industry, trade unions and other groups of civil society. The Commission took note of the Chairman's summary of the industry segment of its sixth session. The following recommendations of the Commission are based on the report of the Secretary-General on industry and sustainable development[15] and the report of the Inter-sessional Ad Hoc Working Group on Industry and Sustainable Development (see annex).

A. Industry and economic development

2. The Commission recognized that industrial policy and responsible entrepreneurship are vital to sustainable development strategies and should encompass a variety of interrelated economic, social and environmental objectives, such as the encouragement of an open, competitive economy, the creation of productive employment and the protection of the environment.

3. The Commission emphasized that in order to achieve the objectives of sustainable development, Governments need to integrate economic, social and environmental concerns in their policy-making and to promote economic growth and international competitiveness of industry through macroeconomic policies. The Commission agreed that, in order to stimulate domestic private enterprise, boost economy-wide competitiveness and attract foreign direct investment, policy reforms should aim at creating an enabling policy environment, inter alia, through improvements in infrastructure and education, encouragement of research and development, facilitation of exports and liberalization of domestic markets. In this regard, the development of small and medium-sized enterprises should receive special attention.

4. The Commission stressed that for developing countries and economies in transition, foreign direct investment is often an important source of capital, new technologies, organization and management methods, and access to markets. The Commission also stressed that to promote foreign direct investment flows to developing countries, in particular to the least developed among them, greater emphasis should be placed by the United Nations system on promotional and information-dissemination activities relating to investment opportunities in the developing countries. In this respect, the programme of the United Nations

[1] For the discussion, see chapter VI below.

[15] E/CN.17/1998/4 and Add. 1-3.

Industrial Development Organization on investment promotion has proved to be an effective instrument for facilitating investment in developing countries and therefore should be strengthened.

5. The Commission emphasized that official development assistance remains a main source of external funding, particularly for countries in Africa and the least developed countries, and plays a significant role, inter alia, in capacity-building, infrastructure, poverty eradication and environmental protection in developing countries, and a crucial role in the least developed countries.

6. The Commission recognized that industry plays a critical role in technological innovations and research and development activities, which are crucial for the economic and social development of any country, as well as in the development, diffusion and transfer of environmentally sound technologies and management techniques, which constitute a key element of sustainable development.

7. The Commission emphasized that it was important for the achievement of sustainable development for Governments to develop and maintain an enabling policy framework based on a sound regulatory foundation complemented with a judicious mix of economic instruments, voluntary initiatives and agreements and public-private partnerships.

B. Industry and social development

8. The Commission recognized that there is a mutually reinforcing relationship between social and industrial development, and that industrialization has the potential to promote, directly and indirectly, a variety of social objectives such as employment creation, poverty eradication, gender equality, labour standards, and greater access to education and health care. In this regard, the overriding policy challenge is to promote the positive impacts while limiting or eliminating the negative impacts of industrial activities on social development. The Commission noted that improved access to education and health care has, in general, been associated with the pace of industrialization and recommended that Governments continue to give them priority.

9. The Commission recognized that industry contributes to social development objectives through, inter alia, the creation of productive employment, compliance with labour standards, corporate social initiatives and attention to human resources development and worker welfare. Industry continues to face such challenges, which can be addressed through better dialogue with trade unions and Governments.

10. The Commission acknowledged that, in dealing with the problems of industrialization, social policy has not always been gender neutral. In view of persistent gender disparities in areas such as income, employment, education and health, Governments, industry, trade unions, women's organizations and other organizations of civil society should work together towards the elimination of discrimination against women.

11. The Commission emphasized that among the central concerns of the international community should be the growing international income disparities among and within countries and the risk that some countries and groups might fall deeper into poverty and exclusion. The World Summit for Social Development provided a strong basis for international cooperation, including with the business community. In this regard, policies should build on the Copenhagen Declaration on Social Development.[16]

[16] *Report of the World Summit for Social Development, Copenhagen, 6-12 March 1995* (United Nations publication, Sales No. E.96.IV.8), chap. I, resolution 1, annex I.

C. Industry and environmental protection

12. The Commission noted that, as the world has become more industrialized, there have been increasing environmental pressures such as harmful emissions and waste, which have had global, regional or local impacts. These include, at the local level, urban air pollution, contamination of soils and rivers and land degradation; regionally, acid rain and water and coastal zone contamination; and globally, climate change, ozone layer depletion, loss of biodiversity, increased movement of hazardous waste and increased land-based marine pollution.

13. The Commission acknowledged that environmental sustainability and industrial development are mutually supportive, given appropriate technology, institutions, policies and systems of incentives.

14. The Commission stressed that the overriding task facing Governments is to maximize the positive influence of industrial activities on economic and social development, while minimizing the negative impact of production and consumption on the environment. To this end, Governments should review their regulatory policies and systems of economic incentives and disincentives and undertake other actions such as capacity-building, environmental data collection and enforcement that support the environmental protection efforts of industry and civil society. Governments should encourage the wider dispersion and implementation of industry's voluntary initiatives and agreements and sharing of best practices.

15. The Commission called upon industry to increase its efforts, as appropriate, in the areas of responsible entrepreneurship and employment of various corporate management tools, including environmental management systems and environmental reporting, to improve its environmental performance. Governments and industry must work together to develop policies to ensure that conformance with standards is not too costly or difficult to achieve for companies in developing countries and for small and medium-sized enterprises.

16. The Commission recognized that eco-efficiency, cost internalization and product policies are also important tools for making consumption and production patterns more sustainable. In this regard, attention should be given to studies that propose to improve the efficiency of resource use, including consideration of a tenfold improvement in resource productivity in industrialized countries in the long term and a possible factor of four increase in industrialized countries in the next two or three decades. The United Nations Environment Programme/United Nations Industrial Development Organization Cleaner Production Centres have demonstrated the compatibility between environmental protection and increased resource productivity, and the lessons learned in these activities should be implemented as broadly as possible.

D. Future work

17. The Commission recognized the value of the interactive dialogue between representatives of Governments, industry, trade unions, non-governmental organizations and international organizations in the industry segment of its sixth session, which focused on four themes: responsible entrepreneurship, corporate management tools, technology cooperation and assessment, and industry and freshwater. Similar dialogues should be held in the future, taking into account that their preparation must take place in the intergovernmental process and with balanced representation of all major groups from developed and developing countries.

18. The Commission noted the potential value of a review of voluntary initiatives and agreements to give content and direction to the dialogue between Governments and the representatives of industry, trade

unions, non-governmental organizations and international organizations. As a first step, representatives of industry, trade unions and non-governmental organizations should examine voluntary initiatives and agreements to identify those elements that can be considered for this review. The Department of Economic and Social Affairs of the United Nations Secretariat could provide assistance in this process. Special attention should be given to the balanced involvement in the process of representatives from all major groups from developed and developing countries. The Secretariat should make the results of this review available to Governments. The Commission invited the Department, in cooperation with the United Nations Environment Programme and the United Nations Industrial Development Organization to examine how voluntary initiatives and agreements could contribute to the future work of the Commission and to report on the result of this work to the Commission at its seventh session.

19. The United Nations Environment Programme is currently undertaking work on the voluntary commitments and initiatives taken by the financial sector that promote sustainable development. The work of the financial sector should be further developed. The Commission underlined the importance of such voluntary commitments and initiatives and invited the United Nations Environment Programme to report on its work in this area.

Annex

Report of the Inter-sessional Ad Hoc Working Group on Industry and Sustainable Development

I. Introduction

1. The Inter-sessional Ad Hoc Working Group on Industry and Sustainable Development met in New York from 2 to 6 March 1998 in preparation for consideration of the issue of industry and sustainable development by the Commission on Sustainable Development at its sixth session (New York, 20 April - 1 May 1998). Its discussions were based on the recommendations and proposals for action contained in the relevant reports of the Secretary-General.[15]

2. The outcome of the Working Group meeting is not a negotiated text, although its contents were thoroughly discussed. In accordance with the expert nature of the Working Group and the functions assigned to it, the present report focuses on key issues and conclusions and suggests elements and policy options for further consideration and negotiation during the sixth session of the Commission on Sustainable Development.

II. Industry and sustainable development

A. Background

3. Agenda 21[17] and the Rio Declaration on Environment and Development[18] provide the fundamental framework for further policy discussion and action on matters related to industry and sustainable development. Although the role of business and industry, as a major group, is specifically addressed in chapter 30, issues related to industry and economic development, consumption and production patterns, social development and environmental protection cut across the entirety of Agenda 21, including its section 4, Means of implementation.

4. Poverty eradication is central to sustainable development strategies, and industry has a key role to play in this respect. Sustainable industrial policy encompasses a variety of interrelated economic, social and environmental objectives, including the encouragement of an open, competitive economy, the creation of productive employment in order to provide sustained increases in household income and social development, and the protection of the natural environment through the efficient use of resources. In order to achieve the objectives of sustainable development, Governments need to integrate economic, social and environmental concerns into their policy and regulatory frameworks, and industry needs to promote sustainable development through sustainable consumption and production and responsible entrepreneurship, in accordance with country-specific conditions.

5. Increasing industrialization and per capita levels of production have led to a corresponding increase in the impact of industrial activities on the environment and health. At the local level, industrial emissions contribute to urban air pollution and the contamination of soil and water. At the regional level, the impact of such emissions includes acid rain, water contamination and the contamination of coastal zones. The major impact at the global level includes climate change, depletion of the ozone layer and the loss of biological diversity. These environmental challenges will be more and more shaped by growing resource and energy demands, and the issues (like climate change) cannot be dealt with by end-of-pipe regulation alone. Hence, the promotion of cleaner production and improvements in environmental performance and environmentally sound technologies and products are becoming increasingly important. Some businesses and industries have taken significant first steps to develop, implement and improve their policies and practices to promote sustainable development. The implementation of environmental management systems and practices in industry are, therefore, important. The way in which companies are able to respond efficiently and effectively to these challenges is seen as a cornerstone in the necessary innovation process.

B. General recommendations

6. Further action is needed to adjust policy approaches that have unintended adverse environmental or social effects and to establish a policy framework that fosters sustainability, including encouragement to companies of all sizes and in all sectors to integrate sustainable development into their business strategies, planning and operations. At the macroeconomic level environmental protection and "eco-management" can contribute to the modernization of the economy and to creating and securing jobs in industry.

---

[17] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992,* (United Nations publication, Sales No. E.91.I.8 and corrigenda), vol. I: *Resolutions adopted by the Conference,* resolution 1, annex II.

[18] Ibid., annex I.

7. Governments are encouraged to develop enabling policy environments and undertake reforms that provide more consistent economic and other incentives and disincentives to make markets work better and encourage business and industry to move faster towards sustainable development. Some policy instruments used in developed countries might be useful for the more advanced developing countries. For others at the early stages of industrialization, there are opportunities to integrate sustainability from the outset. For developing countries, particularly the least developed countries, further efforts, supported by international cooperation, will need to be made in order to encourage capacity-building and investment in sustainable industrial development.

8. Since the role of the private sector has expanded in most economies, effective sustainable development policies require constructive dialogue and partnerships between Government at all levels, industry, trade unions and civil society, including women's organizations. There is a need to build and extend this dialogue. There are many good examples of the new partnerships that are required. They include partnerships between Government and industry to tackle global challenges like climate change, partnerships between companies in developed and developing countries to create and spread cleaner technologies and improved environmental management, partnerships at national and local levels between companies and all of their stakeholders, and increased dialogue between industry and the United Nations system.

9. Consistent with Agenda 21, the development and further colaboration of national policies and strategies and integrated approaches, particularly in industrialized countries, are needed to encourage changes in unsustainable consumption and production patterns, while strengthening, as appropriate, international approaches and policies that promote sustainable consumption patterns on the basis of the principle of common but differentiated responsibilities, applying the "polluter pays" principle and encouraging producer responsibility and greater consumer awareness.

10. Governments, industry and organizations of civil society should, as appropriate, use the media, advertising, marketing and other means to promote greater producer and consumer awareness of sustainable development in order to encourage a shift to more sustainable consumption and production patterns. Industrialized countries should take the lead in this process.

11. Sustainable development should be encouraged with continuous innovation and the adoption of environmentally sound technologies to change current production and consumption patterns. The challenge is to implement measures that will have a significant long-term impact on preventing and mitigating pollution and resource consumption alongside continued growth in gross domestic product. Eco-efficiency, cost internalization and policies for products and services are important tools for making consumption and production patterns more sustainable.

12. Foreign investment can play a significant and positive role in achieving sustainable development -- for example, through the diffusion of environmentally sound technologies, including environmental management techniques and tools, and in capacity-building and poverty alleviation through employment generation. It can, however, contribute to environmental problems when undertaken with inadequate regard to environmental, economic and social consequences. Consideration should be given to an assessment of the implications for sustainable development of foreign investment.

13. Business and industry should be encouraged to develop and implement voluntary guidelines and codes of conduct which can help to promote and disseminate best practices in environmentally and socially responsible entrepreneurship, and to develop further those that already exist. To be

effective, business and industry need to develop and implement such codes by themselves, for that will ensure their commitment to the process. Equally important, their credibility with stakeholders requires that the codes stimulate positive action that goes well beyond "business as usual". Therefore, an essential element is transparency in monitoring and public reporting of progress.

14. Governments at all levels, industry, trade unions and other organizations of civil society, in particular women's organizations, should work together towards the elimination of discrimination against women in employment, education, property ownership and access to credit and to ensure that women have effective equal access to economic opportunities and social participation. Governments should ensure that their social and industrial policies are gender-sensitive.

15. Particular efforts are needed to promote small and medium-sized enterprises and entrepreneurial potential, in, inter alia, the informal sector in developing countries. Sustainable development requirements need to be translated into concrete action for small and medium-sized enterprises. Governments, with the support of the international community, as appropriate, can develop policy frameworks to support investment, including the provision of micro-credit, and access to technology know-how and training. Large companies and transnational corporations can provide support by working through the supply chain, including local suppliers.

16. Training should be utilized by all sectors and societies to promote cleaner production. The training should stress the integration of economic, social and environmental matters as Government, industry and civil society implement the policies and programmes.

C. Recommendations for Governments

17. Within a supportive international environment, Governments should create an enabling policy environment in order to encourage domestic private enterprise and economy-wide competitiveness through improvements in infrastructure and educational, financial and legal institutions; encourage research and development; and facilitate exports and the liberalization of domestic markets. These reforms can encourage investment, innovation, diffusion of technology and more efficient use of resources.

18. Governments should continue to promote the integration of environmental and industrial policies, with emphasis on the preventive approach. Governments need to adopt policies and regulations that set clear environmental goals and objectives for industry through strategic environmental policies at the national and subnational levels. They also need to develop and promote appropriate policy frameworks to help mobilize the full range of domestic and foreign resources from all sectors, including industry, in support of sustainable development.

19. Since not all developing countries can attract adequate levels of foreign direct investment for their industrial development, official development assistance remains a main source of external funding for them, particularly in Africa and in the least developed countries. Official development assistance plays a significant role, inter alia, in capacity-building, infrastructure, poverty alleviation and environmental protection in developing countries, and a crucial role in the least developed countries.

20. Development strategies should encompass official development assistance and should include the effective use of all possible means of promoting sustainable development and the facilitation

of private investment, trade, technology transfer, and utilization of science and technology, tailored to the specific conditions and needs of each country. It is urgent that measures be taken to foster and improve capacity-building over the long term.

21. While not replacing official development assistance, foreign direct investment offers developing countries and economies in transition access to additional capital, new technologies, organization and management methods, and markets, as well as opportunities to exploit complementarities between domestic and foreign investment. A stable policy environment is necessary to attract foreign direct investment and to ensure confidence among domestic entrepreneurs and foreign investors. Ways and means of encouraging foreign direct investment flows between developing countries should be explored.

22. Governments in developed countries should encourage foreign direct investment to assist developing countries and economies in transition in their development in a way friendly to the environment and supportive of sustainable development. The commitment of foreign investors to sustainable development is required while they pursue their commercial interests.

23. To ensure that such investments are supportive of sustainable development objectives, it is essential that the national Governments of recipient countries provide appropriate regulatory frameworks and incentives for private investment, including those that promote the availability of micro-credit. Therefore, further work should be undertaken on the design of appropriate policies and measures aimed at promoting long-term investment flows to developing countries for activities that increase their productive capability and at reducing the volatility of those flows.

24. When devising and implementing environmental regulatory frameworks, Governments should seek to ensure that such frameworks encourage, as appropriate, private sector activities that promote sustainable development. The traditional method of command and control, based on effluent and emission standards, should be developed or modified, as appropriate, with ample participation of industry and civil society, to become an enabling factor and the basis for a judicious mix of economic instruments, voluntary industry initiatives and public and private partnerships.

25. There is a need for making existing subsidies more transparent in order to increase public awareness of their actual economic, social and environmental impacts, and for reforming or, where appropriate, removing them. Further national and international research in this area should be promoted in order to assist Governments in identifying and considering phasing out the subsidies that are market-
distorting and have socially and environmentally damaging impacts. Subsidy reductions should take full account of the specific conditions and the different levels of development of individual countries and should consider potentially regressive impacts, particularly on developing countries. In addition, it would be desirable to use international cooperation and coordination to promote the reduction of subsidies where they have important implications for competitiveness.

26. Governments should encourage the implementation of environmental management systems. In order to widely disseminate environmental management concepts in small and medium-sized enterprises, especially in developing countries, the instruments and methods of environmental management have to be adapted to their specific capacities and needs, making them easier to apply and less costly. Networks of intermediaries that can assist small and medium-sized enterprises in improving their environmental performance should be encouraged.

27. Governments, at the national level, are encouraged to address the issue of occupational health and safety standards in small and medium-sized enterprises and in industry.

28. Increased efforts are needed by Governments, in cooperation with industry, trade unions and civil society, to ensure universal compliance by industry, including informal enterprises, of core labour standards as contained in the Conventions of the International Labour Organization. Such standards include freedom of association, the right of collective bargaining, prohibition of forced and child labour, and non-discrimination in employment.

29. Governments can set a good example and create a market for more environmentally friendly products and services by providing, as appropriate, adequate infrastructure, establishing goals on procurement that take account of environmental factors and encouraging all relevant governmental bodies to introduce environmental management systems. Governments can improve the quality of information on the environmental impact of products and services and, to that end, encourage the voluntary and transparent use of eco-labelling.

30. Social objectives should be an integral part of sustainable development, and the overriding social policy challenge for Government and industry is to promote the positive impacts of industrial activities on social development, while limiting or eliminating the negative impacts. This can be achieved by various means, in particular through improved access to education and health care. Governments should give priority to ensuring universal access to basic education and to expanding access to secondary education. Tax incentives, for example, may be useful to encourage companies to invest in training and education for their workers. Governments and civil society should also address the problem of rapidly expanding labour forces, especially youth labour.

31. Since the creation of employment plays a pivotal role in the alleviation of poverty, industrial policies should promote linkages between enterprises in the formal and informal sectors, including transnational corporations.

32. Governments, where appropriate, should cooperate with industry, trade unions and other concerned organizations of civil society in expanding, strengthening and ensuring the sustainability of social security schemes. Governments should also ensure that the benefits of pension systems are secure and transferable between employers. Moreover, Governments, in cooperation with industry, should ensure that such coverage is as broad as possible and, where feasible, based on mandatory worker and employer participation.

33. The fulfilment of greenhouse gas emission reduction targets agreed upon in the Kyoto Protocol to the United Nations Framework Convention on Climate Change[19] needs to be achieved within set time-frames in developed countries. The fulfilment of commitments assumed by different countries, in accordance with the principle of common but differentiated responsibilities, is important.

34. Attention should be given to studies that propose to improve the efficiency of resource use, including consideration of a tenfold improvement in resource productivity in industrialized countries in the long term and a possible fourfold increase in resource productivity in industrialized countries in the next two or three decades. Further research is required to study the feasibility of these goals

[19] Adopted at the third session of the Conference of the Parties, on 11 December 1997.

and the practical measures needed for their implementation. Industrialized countries will have a special responsibility and must take the lead.

35. The concept of eco-efficiency should not be a substitute for changes in unsustainable lifestyles of consumers, and the pursuit of eco-efficiency also requires enhanced efforts to assist developing countries in their efforts to promote sustainable consumption and production patterns, by improving access to financial resources and environmentally sound technologies.

36. Voluntary initiatives by all subsectors of industry have been a valuable tool in protecting the environment. Governments should continue to encourage voluntary initiatives by industry, in both the formal and informal sectors, including voluntary and transparent codes of conduct, charters and codes of good practice, and the conclusion of voluntary agreements. Effective monitoring and follow-up programmes with stakeholder participation are needed, and industry should provide better and more complete dissemination of information of their voluntary initiatives. In addition, the assessment of progress made throughout a sector or country needs to be facilitated by developing a set of relevant indicators and metrics.

37. In order to strengthen domestic technological capabilities, it is useful for Governments to develop a national science and technology strategy and to support capacity-building to promote partnerships with industry. Greater cooperation between industry and public research and development bodies is needed to develop the skill and knowledge base necessary for a successful domestic technology strategy and the absorption of imported technologies.

38. Technology transfer and cooperation and the development of the human and institutional capacities to adapt, absorb and disseminate technologies and to generate technical knowledge and innovations are part of the same process and must be given equal importance. Governments have an important role to play in providing, inter alia, research and development institutions with incentives to promote and contribute to the development of institutional and human capacities.

39. Control and influence over the technological knowledge produced in publicly funded research opens up the potential for the generation of publicly owned technologies that could be made accessible to the developing countries and could be an important means for Governments to catalyse private-sector technology transfers. Proposals for the further study of the options with respect to those technologies and publicly funded research and development activities are welcomed.

40. The Governments of developed countries are invited to encourage private-sector companies in their countries to transfer environmentally sound technologies to developing countries. Such transfers should be underpinned by matching technical assistance and the transfer of education and skills, taking into account the unique circumstances and characteristics of small and medium-sized enterprises.

41. The ongoing process of globalization may bring with it a higher rate of technological progress and diffusion. Innovations in industry and their diffusion will no doubt be among the most important mechanisms for progressively delinking economic growth from environmental degradation. The dynamics of innovation in industry thus deserve careful study so as to determine what triggers innovation and how innovations are taken up by society. Studies are also needed on the possible environmental and social effects of innovation. Policies, including incentives, are needed which can steer innovation and investment in directions conducive to sustainable development.

D. Recommendations for industry

42. Companies can enable consumers to make more informed choices by providing reliable and accurate information on the impacts, and where possible, conditions of production and qualities of products and services, through their marketing and advertising activities, environmental reporting and improved stakeholder dialogue.

43. Industry and civil society should work with Governments to strengthen secondary, vocational and advanced education and to ensure that it meets the developmental needs of society and the economy. This includes fair treatment of employees and constructive training programmes.

44. Environmentally oriented management should aim at both preventing environmental damage and encouraging sustainable use of natural resources through, for example, more efficient use of energy, water and raw materials; the reduction of emissions into the air, water and soil; the reduction of noise impacts; the reduction of waste; and the development of environmentally sound products and services. Environmental management systems and practices suitable to particular circumstances can enable business to control its environmental impacts and stimulate awareness of sustainability as a key business issue. To maintain and enhance competitiveness over the longer term, companies need to integrate environmental and social sustainability into their strategic planning. This includes developing cleaner products and processes that use resources more efficiently and minimize environmental impacts.

45. Industry should act to improve its environmental performance through appropriate implementation of environmental management systems. For example, transnational corporations should consider setting a time-frame within which to fully implement such systems. At the same time, Governments and industry must also work together to develop policies to ensure that compliance with standards is not too costly or difficult to achieve for companies in developing countries. National certification schemes should be based upon the principles of transparency and non-discrimination and should not be used as non-tariff trade barriers.

46. Large corporations should apply best practice in their own branches, both domestically and abroad. Companies are encouraged to provide environmentally sound technologies, supported by appropriate management techniques and training, inter alia, so as to help companies in other countries, particularly developing countries, to develop and implement environmentally sound policies. Those companies and corporations should also be proactive in promoting the implementation of core labour standards of the International Labour Organization.

47. Chambers of commerce and business organizations in developed and developing countries should be encouraged to cooperate in the transfer of technology and in the development of management tools and institutional frameworks for sustainable development.

48. There is a growing trend among a variety of stakeholders to hold industry accountable and responsible for the environmental impact of its operations and products throughout their entire life cycle. The industry and business sectors should respond positively to these demands by continuing to develop voluntary codes of conduct, charters and codes of practices. Industry and business should observe these codes when operating in developing countries and in economies in transition, in particular where environmental enforcement is still being developed.

49. The financial sector has an important role to play in promoting sustainable development. Voluntary commitments and initiatives taken by the financial sector (banks, savings and micro-credit institutions, and insurance companies) which promote sustainable development should be further developed and implemented, and strategies for monitoring progress should be developed. Since financial institutions play an important role in sustainable development in developing countries, their policies may include requirements and incentives to stimulate sustainable development and to report on their progress.

E. Recommendations for the international community

50. The principles of transparency, mutual recognition and non-discrimination, which serve as building blocks for the multilateral trading system, should also serve as basic principles in other areas, such as sustainable development. The development of environmental standards, voluntary codes of conduct and eco-labelling should be viewed as facilitating tools to ensure the fulfilment of environmental objectives, rather than as necessary elements to be checked for the achievement and measurement of sustainability.

51. The international community needs to assist developing countries and economies in transition in their efforts to facilitate their adoption of production technologies that reduce environmental pressures while, at the same time, allowing them to be more competitive in international markets. Therefore, there is a real need to disseminate information about environmentally sound technologies to developing countries on a broader scale. The United Nations Industrial Development Organization, the United Nations Environment Programme, the United Nations Conference on Trade and Development and other relevant bodies should be invited to focus their programmes in order to promote the transfer of environmentally sound technologies, particularly to small and medium-sized enterprises in developing countries.

52. The international community, working notably through the United Nations Educational, Scientific and Cultural Organization, the United Nations Industrial Development Organization, the United Nations Environment Programme, other United Nations bodies active in the implementation of chapters 30 and 36 of Agenda 21, and non-governmental organization partners, should strengthen the links between education and industry leading to sustainable development by assisting developing countries in their national efforts to strengthen secondary, vocational and advanced education.

53. When promoting measures favouring eco-efficiency, developed countries should pay special attention to the needs of developing countries, in particular by encouraging positive impacts, and to the importance of avoiding negative impacts on export opportunities and on market access for developing countries and, as appropriate, for countries with economies in transition. Implementation of environmental measures should not result in disguised barriers to trade.

54. Industrialization is a key element in promoting sustainable development in developing countries, particularly in Africa, and the least developed countries. It plays an important role in the efforts of those countries to eradicate poverty, create productive employment and integrate women into the development process. The business community, especially the small and medium-sized enterprises, have a particularly important role in enhancing industrialization. There is a need for the United Nations Industrial Development Organization, the United Nations Environment Programme and other relevant United Nations bodies to enhance their activities in developing and implementing

sustainable industrial development strategies, including taking into account the implementation of the Second Industrial Decade for Africa.

55. The international community, the United Nations Industrial Development Organization and other relevant United Nations bodies are encouraged to provide appropriate financial and technical support to enable industries in developing countries to comply with national environmental goals and objectives through strategic environmental policies at the national and subnational levels.

56. Foreign direct investment can contribute to the achievement of sustainable development. To promote foreign direct investment flows to developing countries, in particular to the least developed among them, greater emphasis should be placed by the United Nations system on promotional and information-dissemination activities relating to investment opportunities in the developing countries.

57. There is a need for a further assessment of the implications of foreign investment for sustainable development, building on past work and taking into account relevant current activities. Such an assessment should take into account all existing relevant activities and processes and build on work undertaken in preparation for the fifth session of the Commission on Sustainable Development. The United Nations Conference on Trade and Development should be invited to investigate the issue and report the results to the Commission at its seventh session. Furthermore, the United Nations Conference on Trade and Development and the World Trade Organization should report on their relevant activities.

58. Multilateral financial institutions, through their investment agreements, programmes and projects, should contribute to sustainable development and the use of environmentally sound technologies.

59. Any negotiations on multilateral investment agreements should be participatory, transparent and non-discriminatory. The negotiations of these agreements should include the specific social, economic and environmental needs of developing countries. A multilateral agreement on investments is currently being negotiated in the Organisation for Economic Cooperation and Development. Without prejudice to the clear understanding in the World Trade Organization that future negotiations, if any, regarding a multilateral agreement on investments will take place only after an explicit consensus decision, future agreements on investments should take into account the objectives of sustainable development, and when developing countries are parties to those agreements, special attention should be given to their needs for investment.

60. Full implementation of the recommendations of the World Summit for Social Development [20] would effectively address growing international income disparities among and within countries and the risk that some countries and groups might fall deeper into poverty and exclusion. Policies are needed to implement the commitments expressed in the Copenhagen Declaration on Social Development[21] to, inter alia, expand productive employment, reduce unemployment, enhance social protection and reduce the vulnerability of the poorest groups. The International Labour Organization

---

[20] See *Report of the World Summit for Social Development, Copenhagen, 6-12 March 1995* (Unnited Nations publication, Sales No. E.96.IV.8).

[21] Ibid, chap. I, resolution 1, annex I.

has a central role in monitoring the implementation of relevant labour standards and in stimulating patterns of economic growth that provide job opportunities. Concerted action by interested countries for the implementation of the 20/20 initiative is making a significant contribution to some developing countries, particularly the least developed.

61. Development of policies to implement the outcome of the Fourth World Conference on Women, which reaffirmed the advances made at the United Nations Conference on Environment and Development and emphasized the need to mainstream a gender perspective into the development agenda, is of great importance.

62. Further work should be undertaken at the international level to develop criteria to improve corporate environmental reporting. The United Nations Environment Programme and the United Nations Conference on Trade and Development could take the lead in that respect, in cooperation with other organizations, as appropriate.

63. Reflecting the sectoral focus on freshwater, the United Nations Environment Programme, working jointly with other relevant United Nations bodies, should be invited to cooperate with the relevant industry sectors to develop a voluntary statement of business-led commitment on the protection and sustainable management of water resources.

64. The secretariats of international conventions on the environment should consider the need to include technology and other technical information in a "clearinghouse" to facilitate fulfilling the commitments of the conventions.

65. Concern was expressed regarding the impact of the current intellectual property regime and the need for protection of intellectual property rights in the transfer of environmentally sound technologies. The international community should promote, facilitate and finance, as appropriate, access to and transfer of environmentally sound technologies and the corresponding know-how, in particular to developing countries, on favourable terms, including concessional and preferential terms, as mutually agreed, taking into account the need to protect intellectual property rights as well as the special needs of developing countries for the implementation of Agenda 21. Current forms of cooperation involving the public and private sectors of developing and developed countries should be built upon and expanded. It is important to identify barriers and restrictions to the transfer of publicly and privately owned environmentally sound technologies with a view to reducing such constraints, while creating specific incentives, fiscal and otherwise, for the transfer of such technologies.

66. South-South cooperation is an important instrument for facilitating the diffusion of technology and industry and as a complement to North-South relations. South-South cooperation could be further strengthened through such innovative mechanisms as trilateral arrangements. Such mechanisms should be supported as an important means of achieving sustainable development and the alleviation of poverty. The United Nations Environment Programme, the United Nations Industrial Development Organization and other relevant United Nations bodies should be invited to sustain and strengthen their programmes that promote the transfer of environmentally sound technologies, particularly to small and medium-sized industries in developing countries. Regional cooperation should also be encouraged and strengthened.

F. Future work

67. Relevant international organizations should study the different voluntary schemes that have been formulated with regard to industry, the effects of the technologies used to cope with problems and the prospects for introducing them elsewhere. It is important that, where necessary, they should create a framework to support the strengthening of efforts by the industry side.

68. The Commission should consider, with industry, how follow-up to the dialogue established with industry might be maintained and developed to ensure effective and continuing contributions from industry to the Commission's work programme. In so doing, the Commission should also consider how industry, through its international and sectoral organizations, should be consulted and associated with the follow-up to that dialogue. The Commission should, in cooperation with other relevant intergovernmental bodies, industry, trade unions, non-governmental organizations and other major groups, establish a process to review the effectiveness of voluntary initiatives intended to promote sustainable and equitable business practices. It is also important that the Commission continue to address the role of industry in sustainable development in the context of different sectoral and cross-sectoral themes allocated for its future sessions. The result of the work undertaken in the follow-up to the Joint Statement on Common Interests by the Secretary-General of the United Nations and the International Chambers of Commerce could be taken into account in further dialogue with industry in the Commission.

69. Governments and industry should be encouraged to improve, in general, their reporting of progress in voluntary initiatives and environmental protection and, in particular, as a follow-up to the industry segment at the sixth session of the Commission. Such reporting and follow-up activities should have the active involvement of the Commission, the United Nations Environment Programme, the United Nations Conference on Trade and Development, the United Nations Industrial Development Organization and others -- for example, the International Chambers of Commerce and the World Business Council on Sustainable Development, at the international level, and trade associations at the subsectoral level. The involvement of trade associations at the subsectoral level may be useful for ensuring better reporting in key subsectors such as energy and transport, mining, cement, paper and pulp, iron and steel, and chemicals. Discussion of changing consumption and production patterns at the seventh session could provide the first opportunity for such enhanced voluntary reporting.

Decision 6/3: Transfer of environmentally sound technology, capacity-building, education and public awareness, and science for sustainable development[1]

1. The Commission on Sustainable Development:

(a) Takes note of the report of the Secretary-General[22] and related background documents dealing with the transfer of environmentally sound technology, capacity-building, education and public awareness, and science for sustainable development;

---

[1] For the discussion, see chap. V below.

[22] E/CN.17/1998/6 and Add. 1-3.

(b) Recognizes that the transfer of environmentally sound technology, capacity-building, education and public awareness, and science for sustainable development are critical elements of a national enabling environment necessary to achieve sustainable development, which includes economic and social development and environmental protection;

(c) Reaffirms the importance it attaches to the two overarching themes, eradication of poverty and sustainable consumption and production patterns, for the programme of work of the Commission, adopted at
the nineteenth special session of the General Assembly;

(d) Recalls that the Rio Declaration on Environment and Development[23] and the General Assembly, at its nineteenth special session, recognized that poverty eradication is essential for sustainable development; reaffirms the urgent need for the timely and full implementation of all the relevant commitments, agreements and targets already agreed upon since the United Nations Conference on Environment and Development by the international community, including the United Nations system and international financial institutions; and, in this context, notes the efforts to achieve the above targets as well as the target to reduce by one half by 2015 the proportion of people in extreme poverty;[24]

(e) Reaffirms that renewed commitment and political will for mobilizing national and international financial sources of public funds, including official development assistance, and encouraging private investment in all these areas is urgently required, particularly for developing countries, if they are to meet their needs for the transfer of environmentally sound technology, capacity-building, education development and public awareness and scientific capabilities;

(f) Encourages the greater use of public and market-based policy instruments and incentives to promote better management of human and natural resources and the development of national capacities to more effectively develop, adapt, integrate and use new technologies;

(g) Welcomes the trend demonstrated in each of the areas towards greater public participation and decentralization, including broader civil society consultations, citizen empowerment and increasing public/private partnership and networks, resulting in more demand-driven efforts at capacity-building, education and public awareness, science development and transfer of environmentally sound technology;

(h) Recognizes the special needs, skills and experience of girls and women, youth, indigenous people and local communities, as well as vulnerable and marginalized groups, in all areas of capacity-building, education and training, science and the use of environmentally sound technology and stresses the need to ensure their equal access to educational and capacity-building opportunities and greater involvement in decision-making at all levels;

---

[23] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992* (United Nations publication, Sales No. E.93.I.8 and corrigenda), vol. I: *Resolutions adopted by the Conference,* resolution 1, annex I.

[24] This target is drawn from the document entitled “Shaping the 21st Century”, issued by the Development Assistance Committee of the Organization for Economic Cooperation and Development in 1996, and has been endorsed by the Development Assistance Committee of Donors.

(i) Encourages Governments that have not already done so to elaborate appropriate policies and plans related to the transfer of environmentally sound technology, capacity-building, education and public awareness and science for sustainable development and ensure that they are fully integrated into national sustainable development strategies and programmes of regional and subregional cooperation.

A. Transfer of environmentally sound technology

2. The Commission on Sustainable Development:

(a) Recalls that Agenda 21[25] and the Rio Declaration[23] provide a fundamental framework for actions on matters related to the transfer of environmentally sound technologies, cooperation and capacity-building;

(b) Welcomes the initiatives of the Governments of the Republic of Korea and the United Kingdom of Great Britain and Northern Ireland to organize inter-sessional meetings on issues relevant to technology transfer, cooperation and capacity-building;

(c) Recognizes that the objectives of sustainable development require continuous technological innovation and the widespread adoption, transfer and diffusion of environmentally sound technologies, including know-how and organizational and managerial procedures, as well as equipment, and that the development of human and institutional capacities to adapt, absorb and upgrade technologies, as well as to generate technological knowledge, is essential for technology transfer, management and diffusion;

(d) Notes that public-private partnerships offer a means of increasing access to, and transfer of, environmentally sound technologies;

(e) Recognizes that the creation of enabling environments at all levels provides a platform to support the development and use of environmentally sound technologies, and in this regard:

(i) The design of legal and policy frameworks that are conducive to long-term sustainable development objectives is a key element of this environment; and

(ii) Governments should try to facilitate the transfer of environmentally sound technologies by creating a policy environment that is conducive to technology-related private sector investments and long-term sustainable development objectives;

(f) Encourages Governments and industry to work together to build capacity in the developing countries for using and maintaining environmentally sound technologies, taking into account that:

(i) Financing programmes for small and medium-sized enterprises, including micro-credit initiatives, are very important; and

(ii) Education and training must also be key priorities in national efforts to develop operating and maintenance skills in the use of environmentally sound technologies;

(g) Calls for the urgent fulfilment of all the commitments of the United Nations Conference on Environment and Development concerning concrete measures for the transfer of environmentally sound technologies to developing countries. The international community should promote, facilitate and finance, as appropriate, access to and transfer of environmentally sound technologies and the corresponding

[25] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992,* vol. I, *Resolutions Adopted by the Conference* (United Nations publication, Sales No. E.93.I.8 and corrigenda), resolution 1, annex II.

know-how, in particular to developing countries, on favourable terms, including concessional and preferential terms, as mutually agreed, taking into account the need to protect intellectual property rights as well as the special needs of developing countries for the implementation of Agenda 21;

(h) Emphasizes that technology cooperation between and among economic actors of developed and developing countries and countries with economies in transition remains a key element in achieving sustainable development objectives. Efforts at enhancing technology cooperation should recognize the critical role of business and industry in technology development, transfer and diffusion, while recognizing the responsibility of Governments to develop policy, legal and institutional frameworks, consistent with sustainable development, in order to promote technology development, transfer and cooperation.

3. The Commission, therefore, decides to include in its future work consideration of policies to promote sustainable production patterns, and, in this context, to consider the concept of eco-efficiency and examples of its application in developed and developing countries, and the transfer of environmentally sound technologies for these purposes. Policy measures should, in particular, focus on the following areas:

(a) National technology strategies and international technology cooperation. In defining policy measures in this area, it is important to identify the potential actors, including Governments, business and industry, research and development institutions and technology intermediaries, and to examine their respective roles, specific interests, capacities and priorities. It is also important to identify barriers and restrictions to the transfer of environmentally sound technologies, in particular to developing countries, and to seek to reduce such constraints, while creating incentives for such transfer, taking into consideration the promotion of cleaner production;

(b) Technology integration, economic competitiveness and environmental management at the enterprise level, including international technology cooperation, at the enterprise level. In defining policy measures in this area, a thorough understanding of the factors that influence companies' environmental and economic performance is needed, including their adoption of best practices in environmental management and the use of environmentally sound technologies in production processes;

(c) In the context of technology transfer and adaptation, it is important that environmentally sound technologies be transferred to developing countries, with support, including, as appropriate, financial support, from developed countries and relevant international institutions, in cooperation with the private sector. In this regard, the experience of the United Nations Industrial Development Organization, the United Nations Environment Programme and other relevant bodies of the United Nations system in establishing cleaner production centres can help facilitate this process.

4. The Commission:

(a) Invites Governments with the assistance of relevant United Nations bodies such as the United Nations Conference on Trade and Development, the United Nations Environment Programme, the United Nations Industrial Development Organization and the Department of Economic and Social Affairs of the United Nations Secretariat, and in consultation with development assistance agencies, to undertake work on the development of voluntary guidelines on technology partnerships involving economic actors of developed and developing countries and countries with economies in transition, in the context of creating and maintaining an enabling environment for the purpose of maximizing the complementary roles of the public and private sectors in the transfer of environmentally sound technologies. Based on experience and emerging opportunities, such guidelines could assist Governments:

(i) In developing policy approaches and implementation strategies for technology cooperation and partnership initiatives;

(ii) In adopting incentives and economic instruments to provide a favourable legal and policy environment for private sector companies from developed countries to participate in technology partnership initiatives with developing countries, supported through an enabling international environment that facilitates access to, and transfer of, environmentally sound technologies and corresponding know-how;

(iii) In applying mechanisms and tools for the assessment of the effectiveness of the transfer of environmentally sound technologies and of technology partnership initiatives with regard to their contribution to achieving economic, social and environmental goals and targets;

(b) Urges Governments, the private sector and research and development institutions of developed countries to identify barriers and restrictions to the transfer of environmentally sound technologies and provide opportunities for technology cooperation, including in research and development, and partnership initiatives involving economic actors from developing countries, particularly African countries and the least developed countries, taking into account conditions and needs of these countries for the transfer of environmentally sound technologies and related capacity-building activities aimed at creating an enabling environment; and welcomes studies in this area;

(c) Encourages Governments of developing countries and countries with economies in transition, with the support of the United Nations system, to develop national strategies for technology innovation, commercialization and diffusion, with a focus on economic or industrial sectors that are particularly important with respect to economic growth, natural resources consumption, efficiency in the use of energy and natural resources in consumption and production patterns and pollution control, taking fully into account the need to create an enabling environment for private sector activities. Regional expert group meetings, jointly organized by Governments and United Nations bodies, including the Department of Economic and Social Affairs of the United Nations Secretariat, the United Nations Conference on Trade and Development, the United Nations Industrial Development Organization, the United Nations Environment Programme and the United Nations Development Programme, can be a useful mechanism to develop guidelines or manuals to assist Governments, upon request, in developing national technology strategies and initiating various forms of partnerships for the implementation of these strategies. The guidance document on national needs assessment for the improved utilization of environmentally sound technologies, adopted by the Commission in 1996, may be useful in developing such guidelines or manuals;

(d) Requests the United Nations Industrial Development Organization and the United Nations Environment Programme, in cooperation with the Department of Economic and Social Affairs, to consider undertaking a study on the effectiveness of incentives to encourage industry to adopt cleaner production technologies. The study should evaluate existing practices and experiences of countries and organizations. The results of the evaluation could be useful to Governments in developing national technology strategies and in ensuring that these strategies are fully integrated into national sustainable development strategies and programmes;

(e) Calls on all Governments, with the support of international organizations and financial institutions, to assist small and medium-sized enterprises, including through funding of feasibility studies on market opportunities and commercial viability of environmentally sound technologies, use of economic instruments,

including fiscal incentives, export promotion programmes, trade initiatives, including economically sound technologies-related issues, and assistance in the development of business plans;

(f) Invites interested Governments of developed and developing countries and countries with economies in transition to undertake, in particular in the context of promoting regional cooperation and implementing international environmental conventions and agreements, in cooperation with the Department of Economic and Social Affairs, the United Nations Conference on Trade and Development, the United Nations Industrial Development Organization, the United Nations Environment Programme and other relevant international bodies, a pilot project on opportunities for sector-specific applications of the recommendations on transfer and commercialization of publicly funded environmentally sound technologies made by the International Expert Meeting on the Role of Publicly Funded Research and Publicly Owned Technologies in the Transfer and Diffusion of Environmentally Sound Technologies, hosted by the Government of the Republic of Korea.[26] The results of this project could be presented to the Commission in 2002. Issues to be considered might include:

(i) Reviewing national legal, institutional, development cooperation and other relevant policies, with a view to removing obstacles to, and providing research and development institutions and the private sector with incentives for, the transfer and commercialization of publicly funded and publicly owned environmentally sound technologies, in particular to developing countries and, as appropriate, countries with economies in transition;

(ii) Assessing existing as well as new technology transfer mechanisms, for example bilateral and multilateral memoranda of understanding and environmentally sound technology pooling or banks, with regard to their potential and use for the transfer and commercialization of publicly funded and publicly owned environmentally sound technologies to developing countries and, as appropriate, countries with economies in transition;

(iii) Considering the creation of additional centres for the transfer of environmentally sound technologies at various levels, including the regional level, which could greatly contribute to achieving the objectives of the transfer of environmentally sound technologies to developing countries;

(iv) Examining various policy approaches to commercialize non-patented or uncommercialized technologies that result from publicly funded research activities, including through the promotion of strategic alliances between research and development institutions, development cooperation agencies, enterprises, technology centres and other intermediaries, and to facilitate access to these technologies by developing countries.

[26] See E/CN.17/1998/12, annex.

Chapter II

Chairman's summary of the industry segment of the sixth session of the Commission on Sustainable Development

1. The new programme of work of the Commission on Sustainable Development for the period 1998-2002, recommended by the General Assembly at its nineteenth special session and approved by the Economic and Social Council in its resolution 1997/63, provides for policy discussion, exchanges of experiences and elaboration of common approaches within specific economic sectors having strong linkages to environmental and natural resources issues. The Bureau of the Commission at its fifth session at the meeting held on 2 and 3 October 1997, suggested that the sixth session of the Commission include a separate "industry segment" to provide an interactive dialogue on industry and sustainable development between the representatives of Governments, industry, trade unions, non-governmental organizations, other major groups and international organizations.

2. During the industry segment, held on 21 and 22 April 1998, four themes were identified for discussion: responsible entrepreneurship; corporate management tools; technology cooperation and assessment; and industry and freshwater.

3. Participants agreed that the interactive dialogue was a constructive innovation in the work of the Commission in response to the outcome of the nineteenth special session of the General Assembly and contributed to the Commission's intergovernmental process. It was also a learning experience, the results of which would need to be taken fully into account by the Commission in preparing for similar events during future sessions. At such future events, it would be important to secure a better balance with respect to the participation of representatives from developed and developing countries as well as in the delegations of major groups.

4. The summary set out below was prepared by the Chairman of the Commission. While the format of the summary does not allow all the views expressed to be reflected in detail, an attempt is made to highlight some general conclusions which met with broad agreement among the participants, those which require more dialogue and better understanding, and specific initiatives suggested by participants.

5. It is expected that the dialogue launched during the industry segment will stimulate further action and collaboration, both within and beyond the aegis of the Commission, to foster stronger partnerships among Governments, as well as between Governments and all other partners concerned, aimed at achieving sustainable development worldwide.

A. Responsible entrepreneurship

6. Participants recognized the important role of responsible entrepreneurship and voluntary initiatives in support of sustainable development, but noted that, although much progress had been achieved by industry, more needed to be done to build upon those achievements. In this regard, it was important to promote the practice of responsible entrepreneurship within more sectors, particularly among small and medium-sized enterprises. It was suggested that more work was necessary to clearly define terms and concepts related to voluntary initiatives and to develop appropriate mechanisms for evaluating the effectiveness and successful characteristics of those initiatives.

7. Representatives of trade unions stressed that responsible entrepreneurship should incorporate democratic principles of participation to promote the participation of workers, trade unions and other major groups in decision-making and implementation. Industry was also urged to recognize the need for universal compliance by industry with core labour standards, as contained in International Labour Organization (ILO) conventions, and to expand productive employment, reduce unemployment, enhance social protection and reduce the vulnerability of the poorest groups.

8. Representatives of industry were of the opinion that they demonstrated a strong commitment to improving environmental performance through voluntary initiatives such as the chemical industry's Responsible Care programme in many countries, as well as initiatives built on the concept of continuous improvement. Representatives of industry suggested that voluntary initiatives should be sector, industry and country specific because no "one size fits all".

9. Participants generally agreed that there should be an integrated approach to promoting responsible entrepreneurship and voluntary initiatives and, in addition to the regulatory framework and incentives provided by Governments to encourage voluntary compliance, there should also be active participation by all stakeholders in the process. It was also important to develop new partnerships between industry, government and other stakeholders.

10. Many participants stressed that, with the spreading practice of responsible entrepreneurship and increasing use of voluntary initiatives, it was important to continue to improve the quality of the reporting of such practices. Concerns were expressed that one of the weaknesses of current corporate reporting was the absence of information that would permit an assessment of the contribution of voluntary initiatives towards achieving sustainability.

11. Representatives of trade unions, supported by non-governmental organizations, presented the view that, in general, voluntary initiatives should have the following features: transparency, accountability and workplace mechanisms to ensure the participation of workers and trade unions; allow monitoring and assessment of corporate practice, beginning with the workplace; ensure access to information for workers, community members and Governments to evaluate the effect of corporate decisions and practices; set quantifiable objectives and comply with environmental law; reflect indicators of sustainable development promoted by ILO; and incorporate the principles of the "right to know", "whistle-blower protection" and the "right to refuse" work where workplace activities were shown to be harmful to the environment.

12. With regard to government policies, many participants emphasized that Governments had an important role to play in promoting responsible entrepreneurship because voluntary initiatives by industry complemented rather than replaced government intervention. In order to promote responsible entrepreneurship, Governments should provide the necessary regulatory framework and use appropriate market mechanisms, including incentives, to encourage actions and behaviour on the part of industry that supported the goal of sustainable development. The use of incentives, for example, could encourage industry to achieve improvements beyond minimum standards. As employment was a cornerstone of sustainable development, education and training policies should be designed to incorporate key elements of sustainable development.

13. A number of speakers stressed that Governments had a crucial role to play in promoting the integration of the social and environmental objectives of sustainable development within industry. Particular attention should be given to developing support programmes to promote responsible entrepreneurship among small and medium-sized enterprises. Particular attention should be given to developing appropriate partnerships

with non-governmental organizations, trade unions and small and medium-sized enterprises by providing financial support, technical training and other capacity-building resources to foster responsible entrepreneurship.

14. Participants recommended that Governments develop an effective dialogue with industry and stakeholders to promote the development of voluntary initiatives and programmes to reach well-defined and time-bound objectives. In partnership with business and industry and international organizations, Governments should promote the development of performance indicators to facilitate the quantification and comparison of the environmental and social performance of companies.

15. In addressing the role of industry, several speakers noted the progress achieved in promoting responsible entrepreneurship since the Rio summit but stressed that more needed to be done to extend and improve the contribution of industry in that area. They considered it important that industry continue to promote best practices. Representatives of industry noted that it was in their own interests to promote sustainable development for the long-term viability of industry.

16. Participants acknowledged that some progress had been made in the reporting on voluntary initiatives and agreements by industry. However, it was noted that in order to improve the quality and scope of reporting, more work was needed to quantify the environmental and social progress achieved by industry. In particular, reporting on social progress was in its infancy.

17. In particular, representatives of non-governmental organizations urged industry to improve its reporting on voluntary initiatives by addressing adequately the issues of transparency, independent verification, standardization and stakeholder involvement. Representatives of trade unions added that the assessment of progress made in a sector or country needed to be facilitated through the development of a set of relevant indicators and metrics.

18. Turning to the role of the industry associations, participants urged those associations to continue and expand proactive servicing of the sustainable development needs of their members and emphasized that they could play key roles, for example, in developing substantive voluntary codes of conduct and building the commitment of the membership to those codes.

19. In view of the fact that foreign direct investment (FDI) was an important vehicle for promoting responsible entrepreneurship, industry was invited to direct more FDI to the least developed countries. Such FDI could complement official development assistance (ODA) and help to spread better business practices into developing countries. Representatives of industry suggested that donors consider an increased share of ODA for capacity-building aimed at creating conditions favourable to the flow of FDI, particularly in least developed countries.

20. The participants highlighted the role of the international community in promoting responsible entrepreneurship, and representatives of non-governmental organizations and trade unions recommended that the sustainable development dimension should be incorporated into international agreements, including agreements in the World Trade Organization and the Multilateral Agreement on Investment currently being negotiated by countries members of the Organisation for Economic Cooperation and Development.

21. In this context, participants emphasized that a global approach was necessary to ensure that environmental and social goals were clearly identified and pursued. The international community should continue to develop, assess and disseminate best practices.

22. Representatives of non-governmental organizations, with support from trade unions, proposed a review by all major groups of voluntary initiatives undertaken by industry. The major groups planned to meet to consider the elements and goals of such a review. Representatives of industry proposed organizing such a meeting in the third quarter of 1998.

B. Corporate management tools for sustainable development

23. The merits of various corporate management tools for sustainable development were discussed, and it was generally agreed that the use of corporate management tools had benefits for industry and other stakeholders. However, it was stressed that no one tool could solve all problems and that each tool had specific strengths and limitations. What was necessary was "tool boxes", on the understanding that companies would need the flexibility to choose the methods best suited to their particular organizational characteristics.

24. There was a large measure of agreement that education, training, technical assistance and information collection and dissemination were crucial for corporate management tools to be successfully implemented. There was also widespread agreement that the special situation and role of small and medium-sized enterprises, especially in developing countries, warranted particular attention. With regard to the implementation of voluntary environmental management systems, it was noted that the involvement of all stakeholders would ensure the best results. Some participants felt that environmental management systems should incorporate independent third-party verification, monitoring of implementation and public reporting of results. On that issue, representatives of trade unions felt that workplaces should be seen as a major focus of action to implement sustainable development goals, and urged that training be utilized by all sectors to promote the knowledge and attitudinal changes necessary for cleaner production, waste reduction, pollution control and energy conservation.

25. Participants stressed that good environmental management should be seen as a long-term process of continual learningand improvement. It entailed an internal transformation that increased awareness, involved employees and changed organizational behaviour. Environmental protection, health and safety systems were fundamental, providing the structure that supported the integration of sustainable development into the day-to-day operation of business, and should be encouraged in companies of all sizes and sectors. Essential elements of an environmental management system included environmental reporting, auditing, objectives, accounting and indicators. Other tools included the precautionary principle, cleaner production, eco-efficiency, life-cycle assessment, durability and design for the environment.

26. With regard to government policies, participants noted that Governments had an important role to play in promoting the use of corporate management tools that improved the performance of industry in meeting the objectives of sustainable development. To this end, Governments should provide regulatory frameworks and incentives to encourage industry to more widely employ corporate management tools such as environmental management systems in order to improve their environmental performance.

27. The view was expressed that Governments should promote fair and rigorous certification and accreditation in order to safeguard the credibility of national, regional and international standards of management systems.

28. Regarding the role of industry in promoting corporate management tools, participants noted that the implementation of tools such as environmental management systems was increasing. Participants urged industry to continue to improve its environmental performance and to increase its collection and

dissemination of data in order to demonstrate that progress, and to keep stakeholders informed of its policies and practices. Business and industry should continue to explore possibilities for verifying adherence to voluntary initiatives such as ISO-14001 and the Eco-Management and Audit Scheme (EMAS).

29. Industry should also develop strategies for bringing small and medium-sized enterprises into the mainstream of good environmental management and for using investment, trade and markets to disseminate good practices, technologies and expertise to developing countries and countries with economies in transition. Multinational companies could play an important role by increasing their cooperation with small and medium-sized enterprises. Partnerships with government and other stakeholders would be crucial to supporting that effort.

30. Furthermore, companies should work with suppliers to spread best practices and support efforts to implement ILO core labour standards and international environmental standards.

31. Representatives of trade unions urged industry to ensure that corporate management tools included the following functions:provide for democratic decision-making in the workplace and participatory mechanisms to involve workers and their trade unions; build on progress made within an industrial relations context which included collective bargaining and other forms of workplace-based agreements between employers and trade unions; promote joint workplace target-setting by employers and trade unions, and encourage joint monitoring programmes, evaluation processes and implementation measures; and promote training and education of workers to enable them to be fully involved in environmental management systems.

C. Technology cooperation and assessment

32. Representatives of industry provided a working definition of technology cooperation and suggested that successful technology cooperation required an efficient market system that provided the financial incentives necessary for technological innovation and investment in modern technology. Technology cooperation and assessment was an important mechanism for progressing towards sustainable development. They suggested that market mechanisms provide the primary vehicle for technology cooperation and assessment. Moreover, exchange of technologies should be a two-way street. Representatives of industry were of the view that technology cooperation and assessment and foreign direct investment, together with increased international trade, had contributed to rapid economic growth and poverty alleviation in several developing countries. They stated that an enabling political and policy framework was required, for example, with regard to political and economic stability, intellectual property rights and an adequate legal framework, and fighting corruption. However, they maintained that it was equally important to ensure that overly restrictive legislation did not encourage the transfer of bad and inappropriate technologies, and to establish joint initiatives to facilitate investment. It was also required that knowledge, skills and equipment be transferred between actors at the local, national and international levels.

33. There appeared to be widespread agreement that technology cooperation should involve the highest degree of safety and environmental protection that was reasonably achievable. Transfer of efficient technologies should be accompanied by high environmental, health and safety standards.

34. Furthermore, some participants emphasized that technologies should be properly assessed, introduced and reviewed in order to avoid causing environmentally and socially adverse impacts in recipient countries. This required advanced education and training. Access to information was crucial and could be supported by a clearing-house mechanism. Representatives of non-governmental organizations called for talent and technology banks to be established at the regional level with the involvement of all stakeholders. As well as

acting as clearing houses, such information banks could make available unbiased information on endogenous environmentally sound technologies and the technologies of indigenous people. They could also promote joint venture development and local ownership of technologies, provide opportunities for scientists to work in their own countries and serve as an office to register and protect intellectual property rights.

35. There was widespread agreement on the need to explore the potential of publicly owned and publicly funded environmentally sound technologies since a proportion of those technologies were held or owned by Governments or public institutions, or resulted from publicly funded research activities.

36. With regard to the role of government, there was broad consensus that Governments should develop and implement policies to create a stable macroeconomic environment and an enabling legal and financial framework to facilitate technology cooperation and attract the foreign direct investment needed for the transfer and dissemination of environmentally sound technologies.

37. There was broad consensus that in order to improve the capacity of local industry to absorb and adapt new technologies, Governments should strengthen educational systems and, in cooperation with other major groups, expand opportunities for training in order to promote the integration of imported technology with locally available technology.

38. Many participants were of the opinion that Governments of developing countries could improve their bargaining capabilities in technology transfer agreements through increased technology assessment capacity. Representatives of non-governmental organizations advanced the view that developing countries, in order to maximize social, economic and environmental benefits, should focus their limited scientific and technical resources on improving their capacity to evaluate and bargain for foreign technology and expertise that would serve national priorities.

39. Many participants were of the opinion that Governments, in their efforts to safeguard the rights of indigenous people, should explore ways and means to compensate indigenous communities for knowledge used in patents on genetic resources.

40. They also felt that industry should further develop and strengthen safety guidelines to prevent adverse effects of technology, including health effects and industrial accidents.

41. Many participants considered that official development assistance should provide more resources for capacity-building in order to improve the absorption of imported technologies in developing countries.

42. International programmes to produce independent, credible verification of environmental technologies could assist users and regulators of technology to make informed decisions, and help suppliers of technology to reach global markets more quickly. The public would benefit through improved environmental quality. Many noted that further work was necessary to identify the types of verification programmes that could be effective.

43. Representatives of trade unions emphasized that technology transfer must serve to protect the environment, promote employment as a cornerstone of sustainable development, and be undertaken with the full range of risk assessment and control procedures already developed in the area of occupational health and safety. Transition programmes should be instituted for workers displaced because of technological change, and workers should be provided with training and education, including international worker exchange programmes, organized with the involvement of trade unions as a basis for effective technology

transfer. Workers and trade unions should be involved in decisions affecting technology changes at the workplace.

44. Representatives of non-governmental organizations called for banks and international financial institutions to provide access to long-term financing for business development by non-governmental organizations utilizing environmentally sound technologies in independent or joint venture projects.

D. Industry and freshwater

45. Several speakers noted that the twenty-first century would witness increasing competition for finite freshwater resources, and that all sectors needed to cooperate if society was to avert or minimize the adverse effects associated with emerging freshwater shortages. Comprehensive freshwater management strategies must involve all suppliers and users. Non-governmental organizations stressed that good water management could not be undertaken by a central Government and had to be designed according to local conditions, with problem-solving based on the involvement of all stakeholders, especially women and indigenous peoples, preferably at a subnational or local level. It was noted that over 1 billion people did not have access to safe drinking water, over 2 billion did not have access to adequate sanitation and 3 to 5 million deaths per year resulted from water-related diseases.

46. Participants emphasized that the integrated watershed management approach had become absolutely necessary in water resources protection. It was imperative to consider the impact of industrial activities on the watershed where a particular industrial site was located, as well as on populations and areas downstream. The impact of the industrial facilities on the ecosystem should be addressed, and the best practices should be implemented in a collaborative approach. In that regard, trade unions felt that the issue of water must be approached in an integrated way, especially with regard to target-setting in the workplace.

47. Participants recognized that education and information were critical for local water resources protection and improving water quality. The involvement of women and indigenous people in improving water quality was especially critical.

48. As to the role of Governments, participants emphasized that special attention needed to be paid to the issue of full pricing of water. Considering that water was an economic, environmental and social good, some participants felt that its pricing should cover costs and risks associated with finding, processing, conserving and delivering water to end-users, as well as meeting the demands of social equity.

49. Participants also noted that agriculture was the largest water consumer and was a crucial sector for the evolution of government water policy, especially in countries experiencing water scarcity.

50. There was broad agreement that Governments should remain ultimately responsible for water protection, supply and delivery. They should play the major role in the treatment and delivery of water, protection of water from abuse, pollution prevention and the promotion of employment through improved management. Governments should establish or maintain standards to ensure the safety of water consumption and prevent health hazards associated with water-related diseases, in close collaboration with industry and other stakeholders.

51. Industry representatives suggested that Governments must accept that there were certain risks which only they could absorb. The private sector did not have the authority or capacity to deal with such problems as acquisition of land and rights of way for the installation of pipelines and plants at an economic cost;

efficient performance by government-owned distribution companies with contracts to purchase water from private-sector water companies; and the financial impact of large changes in exchange rates.

52. There was general agreement that a more comprehensive management of water resources, including pollution-control policies, was necessary. Appropriate regulations or economic incentives and institutional structures should be developed for internalizing the externalities that arose when one user affected the quantity and quality of water available to another group. The effects of damage caused by industries through pollution of surface water and groundwater needed to be taken into account in determining their water tariffs.

53. Participants noted that there was a growing consensus for greater private-sector involvement, taking into account the political, legal, cultural, institutional, financial and technical characteristics of water and sewage systems.

54. Many participants noted that industry could play an active role in a number of areas related to the demand for freshwater for human needs, including research and development of efficient new infrastructure for urban water supply and new technology for the reuse of urban wastewater.

55. Non-governmental organizations stressed that guidelines for monitoring biological and chemical toxicity at both water sources and delivery points could be developed by appropriate United Nations bodies.

56. In the area of sustainable provision of water to meet agricultural needs, some participants suggested that industry could help by promoting best practices in environmental management, including fertilizer and pesticide usage. In addition, some suggested that industrial research and development for improving irrigation technology should be strongly supported. In that context, targets for agriculture use of water should be set and met. Non-governmental organization representatives proposed that the Commission initiate an ongoing dialogue of stakeholder groups to develop common criteria for good practices.

57. Many participants stressed that the environment was not just a sectoral user of water but played a fundamental role in maintaining the quality and supply of water resources for use for other purposes. Industrycould assist in promoting effective environmental management of water and land resources. The chemical and fertilizer sectors, for example, had an important role to play in protecting water quality and life-supporting ecosystems.

58. Many participants suggested that workers and their trade unions be involved with employers in developing workplace eco-auditing tools to address problems of water management.

59. Some participants felt that industry should also develop standards to protect existing water quality and improve substandard sources. Decisions on siting industrial facilities should take into account the quality of the water resources to be used and the impact of the industrial activity on those resources.

60. Industry representatives suggested further work on defining the nature and pricing of natural resources, such as water, in particular the definition of social goods and how they should be monetarized and integrated in market prices. They suggested that two countries be invited to work together to evaluate how to achieve full cost-pricing and manage water tariffs. Two other countries could study how watershed management could contribute to water protection and enhance carbon sinks for greenhouse gases under the "clean development" mechanism.

61. With respect to actions by the international community, many participants suggested that the United Nations system play an active role in harmonizing, at the international and national levels, the recommendations being made to countries for integrated water resources management strategies. In addition, they suggested that the United Nations system play a central role in the development and coordination of data and information networks, strengthen regional and global monitoring systems, conduct periodic global assessments and analyses, promote the broadest exchange and dissemination of relevant information, in particular to developing countries, and increase its role in education efforts.

62. They also suggested that international organizations promote technology transfer and research cooperation in collaboration with Governments and industry to foster sustainable agriculture practices that integrated efficient water use and prevented the pollution of surface water and groundwater.