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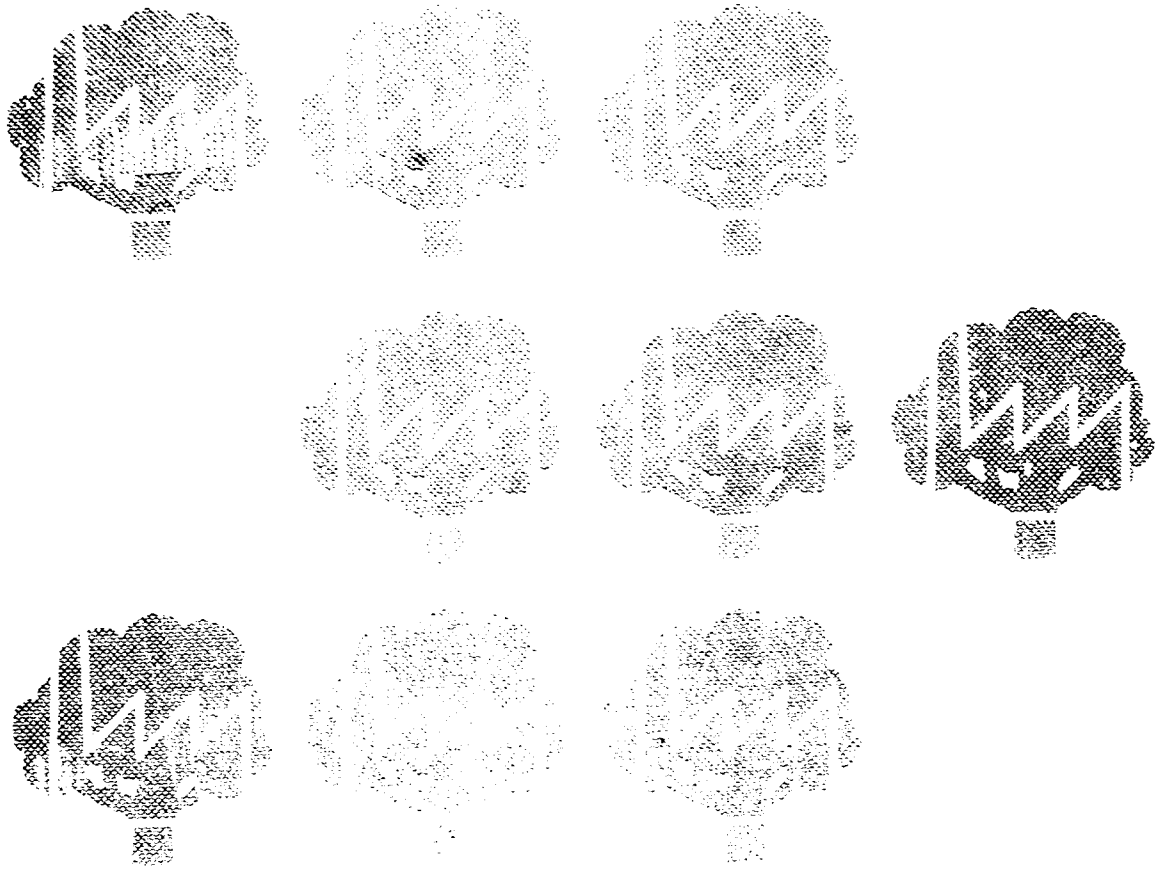

Using biogas energy in Harare

Biological waste from CAIRNS FOODS near Harare, Zimbabwe, is being analysed in preparation for setting up a pilot plant for biogas production.

UNIDO is providing technical expertise under funding from the Finnish Government.

Biological waste of all kinds produces gases when it decays. Some of them, methane in particular, are useful for energy production. Under controlled conditions the gas can be collected and used as fuel. This abundant source of energy is very appropriate for conditions in developing countries. Its economic viability, however, will depend on factors such as installation costs and financing, operating costs and loss of wastes for other uses, e.g. as animal feed, compared to projected revenues from the biogas produced and from the residual sludge, which can be used as fertilizer.

The study will examine such economic factors as well as the exact composition of the waste in Zimbabwe and lead to the establishment of a pilot plant. The experience gained will be published in a manual for general use in developing countries.

PROCEEDINGS OF THE CONFERENCE ON ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

Copenhagen, Denmark
14-18 October 1991

PI/112

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FOREWORD

For all their diversity, environmental problems are global in nature and call for concerted global action. We are thus particularly proud that the Conference on Ecologically Sustainable Industrial Development brought together all parties to the industrial development process - ministers and senior government officials, representatives of the United Nations agencies and other organizations, the NGO community and - last but not least - the private sector, whose activities are assuming an increasingly important role in the work of UNIDO.

While there is no denying that most of the problems we addressed at the ESID Conference have their origin in the industrialized countries, environmental degradation cannot solely be attributed to overconsumption and waste by the affluent in the North. Developing countries, too, face serious problems if they follow the same path that has taken the developed world to its present stage.

Indeed, as we search for ways to bridge the gulf between what humanity needs and what our world can sustain, our thoughts inevitably turn to technological options. As can be seen in this collection of ESID papers, technological solutions to environmental problems abound. They are being successfully applied not only in the five sectors highlighted in the case studies - but across industry at large. The disconcerting fact is, however, that for all their availability, the full potential of these essential technological tools is not being realized.

A host of factors combine to impede the transfer of environmental technology to developing countries. Some, such as trade policies, product and process standards and specifications, are described in the working papers which clearly show that progress in this area depends on the collaboration of all - governments, industry and organizations alike.

The role of governments is, of course, of prime importance. By setting standards and determining their mode of implementation, governments affect in the most direct way the actions and attitudes of industry. But equally important is the effect of bringing the environmental dimension to bear on all planning, policies and expenditures related to industry. Only

through a holistic approach can the effects of ill-considered taxation, price regulation and legislation be avoided.

But regulation and enforcement alone cannot lead to success. Indeed, no ESID policy can hope to be effective unless industrialists, who bear the final responsibility for meeting environmental objectives, are brought into the process. Whether an industry is owned by the State or is private is not the central issue, although the structure of incentives will differ depending on the forms of ownership. Industry must now seek out ways to transform and apply technology in a way that diminishes environmental deterioration. It must commit itself to the concept of Cleaner Production and look at the entire life cycle of its production processes. It must submit to environmental audits, which can provide both entrepreneurs and the public with information on the progress made towards achieving ESID-related objectives. In short, industry must assume its responsibilities.

One can take courage from the examples cited in the Conference documentation on cleaner production options that have been implemented at little or no extra cost. Yet it would be unrealistic to pretend that solutions can always be found without major outlays. The developing countries' financial options are severely limited, given their crippling indebtedness and the resultant shortage of capital needed to finance cleaner production processes. One clear message from the ESID Conference was that international sources of financing need to increase.

In convening the ESID Conference, UNIDO had a number of quite specific objectives. Leading up to the larger United Nations Conference on Environment and Development, the ESID Conference offered a unique opportunity to ensure the appropriate inclusion of industry in the discussion of the world's transition to sustainable development. The 1992 conference in Rio is expected to outline the basic principles for the conduct of nations and peoples so as to ensure the future viability and integrity of the earth as a hospitable home for human and other life. Within that context, there is clearly a role, a challenge and a commitment for industry.

Did the Conference, then, provide the results that we were looking for? Looming issues such as the debt crisis and

overpopulation, keywords like 'additionality' and 'conditionality', fundamental conflicts of interest between developed and developing countries - they are basic themes in international development, and ESID was not the place for sweeping solutions. But in providing the opportunity to address Ecologically Sustainable Industrial Development within that context and determine its place and priority, it was useful.

For UNIDO the Conference provided endorsement of some basic priorities that will set the sights for our environmental activities. We are launching a revision of our Environment Programme, formulated over two years ago, to reflect those priorities. One such central ESID principle is the emphasis on 'cleaner production' or 'pollution prevention' instead of so-called 'end-of-pipe' treatment dealing with the results after emissions have occurred. In order to support the developing countries in harnessing available cleaner production technologies, UNIDO will establish a programme of demonstration projects, where technical solutions and their environmental and economic benefits can be shown. We also hope to create a network of cleaner production centres in developing countries.

The need for guidelines on ESID technologies is specifically mentioned in the ESID recommendations. UNIDO has already published some such guidelines on Environmental Auditing, Risk Management, Leather and Tanning etc. Several have appeared in collaboration with other United Nations agencies, and we are trying to step up this co-operation - noting that it is one of the other specific recommendations of ESID.

The Conference also called for support of developing countries in meeting their obligations under international conventions and protocols. Such a programme is already under way for the Montreal Protocol restricting the use of CFCs and some other substances, and we hope to widen it to include other relevant sectors.

But the importance of the ESID Conference lies not so much in the activities launched immediately after its conclusions and recommendations as in focusing the attention of all the partners in industrial development - governments, industry, NGOs and international organizations - on common goals. The intention was to give the term ESID - Ecologically Sustainable Industrial Development - a currency beyond the actual conference. By discussing the nature of the goals and assigning roles and

strategies in overcoming obstacles, more concerted action will ensue. The useful partnerships that have been established between UNIDO and other organizations and individuals will no doubt constitute a sound basis on which to proceed still further.

Through the year-long preparations for the Conference, the capacity of UNIDO to address environmental issues has greatly developed. The documentation presented in this volume provides up-to-date analyses and data on the situation in industrial sectors and in the international community. This information and the heightened awareness of the issues will continue to have an effect both within UNIDO and without, long after the ESID Conference concluded its deliberations.

The General Conference of UNIDO in November endorsed the recommendations of ESID, and noted with appreciation the outcome of the conference, indicating its confidence in UNIDO to carry on the work. With this expression of support we can - and shall - redouble our efforts.

Domingo L. Siazon, jr.

Director-General of UNIDO

REPORT OF THE CONFERENCE ON ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

REPORT OF THE CONFERENCE ON ECOLOGICALLY SUSTAINABLE INUSTRIAL DEVELOPMENT

Contents

Introduction

1. The Conference on Ecologically Sustainable Industrial Development organized by UNIDO was held at Copenhagen, Denmark, at ministerial level from 14 to 18 October 1991. The Conference was attended by representatives of Member States of UNIDO as well as intergovernmental organizations, industry and non-governmental organizations who participated as observers.

2. The objectives of the Conference were as follows:

(a) To clarify the issues related to ecologically sustainable industrial development (ESID) in all countries, particularly in developing countries, and the manner in which environmental concerns can be integrated into the ongoing industrialization process;

(b) To suggest some important roles for Governments, international organizations, industry, and non-governmental organizations in this regard;

(c) To suggest the role that UNIDO, in cooperation with other United Nations organs, organizations and programmes, could play in supporting such an effort, at both the policy and operational levels; and

(d) To provide an input on industry and the environment for consideration at the United Nations Conference on Environment and Development (UNCED) to be held at Rio de Janairo, Brazil, in June 1992.

3. The following countries were represented at the Conference:

Afghanistan, Algeria, Argentina, Austria, Bangladesh, Barbados, Belgium, Belize, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cameroon, Canada, Cape Verde, Central African Republic, Chad, Chile, China, Colombia, Comoros, Congo, Czechoslovakia, Denmark, Dominican Republic, Ecuador, Egypt, Equatorial Guinea, Finland, France, Gambia, Germany, Ghana, Greece, Guatemala, Guinea, Haiti, Hungary, India, Indonesia, Iran (Islamic Republic of), Italy, Jamaica, Japan, Kenya, Lesotho, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Mauritius, Mexico, Morocco, Mozambique, Nepal, Netherlands, Norway, Papua New Guinea, Peru, Poland, Portugal, Qatar, Republic of Korea, Romania, Rwanda, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Sao Tome and Principe, Saudi Arabia, Senegal, Sierra Leone, Spain, Sudan, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Tunisia, Turkey, Uganda, Ukraine, Union of Soviet Socialist Republics, United Arab Emirates, United Kingdom of Great Britain and Northern Ireland, United Republic of Tanzania, United States of America, Venezuela, Yemen, Zambia, Zimbabwe.

4. Anguilla, Antigua and Barbuda, Australia and Holy See participated as observers.

5. The following organs and offices of the United Nations system were represented:

Department of Technical Cooperation and Development, International Trade Centre UNCTAD/GATT, United Nations Conference on Environment and Development, United Nations Centre for Science and Technology on Development, United Nations Centre for Transnational Corporations, United Nations Development Programme, United Nations Environment Programme, Economic Commission for Europe, Economic and Social Commission for Asia and the Pacific, Economic and Social Commission for Western Asia.

6. The following United Nations specialized and other agencies were represented:

International Labour Office, Food and Agriculture Organization of the United Nations, United Nations Educational, Scientific and Cultural Organization, World Health Organization, General Agreement on Tariffs and Trade.

7. The following other intergovernmental organizations were represented:

Commonwealth Secretariat, European Economic Community, Organization for Economic Cooperation and Development, Nordic Council of Ministers, Organization of Arab Petroleum Exporting Countries, Organization of Petroleum Exporting Countries, Centre for the Development of Industry of the EEC, International Institute for Applied Systems Analysis.

8. The meeting was also attended by representatives of the following non-governmental organizations:

Business Council for Sustainable Development, Centre for Science and Environment, Centre for the Development of Industry, European Confederation of Pulp and Paper and Board Industries, Conservation International, Danish Toxicology Centre, Development Horizons Trust, European Chemical Industry Council, Danish Society for the Conservation of Nature, Greenpeace International, Industriraadet, Institutraadet, Institute for European Environmental Policy, International Chamber of Commerce, International Confederation of Free Trade Unions, International Cooperative Alliance, International Council of Scientific Unions, International Fertilizer Industry Association, International Institute for Environment and Development, International Life Sciences Institute, International Network for Environmental Management, International Union of Architects, European Centre for Plastics in the Environment, International Youth and Students Movement for United Nations, Mazingira Institute, Vor Falles Fremtid, World Association of Industrial and Technological Research Organizations, World Coal Institute, World Conservation Union, World Wide Fund for Nature, Umweltökonomische Studenteninitiative an der Hochschule St. Gallen.

The Conference was also attended by representatives of a large number of research groups and institutions, consultants and private companies.

Agenda item 1: Opening of the Conference

9. The Conference was formally opened by His Royal Highness, Crown Prince Frederik of Denmark. Inaugural statements were made by Anne Birgitte Lundholt, Minister for Industry and Energy of Denmark, and Domingo L. Siazon Jr., Director-General of UNIDO.

Agenda item 2: Election of officers

10. A. B. Lundholt, Minister for Industry and Energy of Denmark, was elected by acclamation to the office of President.

11. The following other members of the Bureau were elected by acclamation:

Vice-Presidents: L. Alvarado (Chile)
C. Forero Pineda (Colombia)
M. Gerente (France)
B. Botos (Hungary)
N. R. Krishnan (India)
H. Mahrou (Iran, Islamic Republic of)
B. Baszczyk (Poland)
J. A. Knauss (United States of America)
M. Malianga (Zimbabwe)

Rapporteur-General: C. Uteem (Mauritius)

B. D. Nielsen (Denmark) was appointed Secretary-General of the Conference.

Agenda item 3: Adoption of the agenda

12. The provisional agenda, as contained in document ID/WG.516/12, was adopted without amendments.

Agenda item 4: Adoption of the rules of procedure

13. The draft rules of procedure for the Conference, contained in document ID/WG.516/11, were adopted without dissent.

Agenda item 5: Ecologically Sustainable Industrial Development

I. Presentation of the themes

14. In the course of their work, the Ministers present at the Conference examined a wide variety of issues relating to ESID. It was agreed that all issues were closely interrelated and that particular attention should be given to the problems confronting the developing countries. The Ministers also noted with concern the particular environmental problems of countries in Central and Eastern Europe. The Ministers agreed that their conclusions and recommendations should lead to specific proposals for implementing a strategy at the national, regional and international levels and through UNIDO in support of ESID. They agreed to transmit their conclusions, recommendations and suggestions to the fourth session of the General Conference of UNIDO and recommended that those conclusions, recommendations and suggestions should also form the basis of the contribution of UNIDO to the United Nations Conference on Environment and Development (UNCED), to be held at Rio de Janeiro, Brazil, in June 1992.

15. Discussion at the Conference was focused on three major themes, each of which was introduced by keynote speakers representing the various categories of participants:

(a) The road to ecologically sustainable industrial development and barriers facing the achievement of ecologically sustainable industrial development

Introductory statements were made by the Director-General of Colciencias (Colombia), the Executive Secretary of the Economic Commission for Europe, the Executive Director of the Business Council for Sustainable Development and the Executive Director of the International Institute for Environment and Development.

(b) Government and industry initiatives in achieving ecologically sustainable industrial development

The debate on initiatives by government and industry in achieving ESID was introduced by the Minister of Environment of Czechoslovakia. Introductory statements were made by the Executive Director of the United Nations Centre on Transnational Corporations, the Secretary-General of the International Chamber of Commerce and the Chairman of the Centre on Science and Environment.

(c) International co-operation in achieving ecologically sustainable industrial development and the role of UNIDO.

The debate on international co-operation in achieving ESID was introduced by the Under-Secretary of Commerce of the United States of America, the Head of Pollution Control Division in the Environment Directorate of the Organization for Economic Co-operation and Development, the Executive Director of the Mazingira Institute (Kenya), and the Secretary-General of the Second World Industry Conference on Environmental Management. The debate was closed with a statement by the Secretary-General of the United Nations Conference on Environment and Development. General statements pertaining to the work of the ESID Conference were made by the representatives of two NGOs, namely Vor Falles Fremtid and the International Fertilizer Industry Association.

II. Conclusions and recommendations

16. The conclusions and recommendations adopted by the Conference are contained in paragraphs 17 to 44 below.

A. GENERAL CONSIDERATIONS

17. The Ministers noted with concern that, although successes had occurred in the 1970s, the gap between developed and developing countries in terms of per capita income and per capita industrial output narrowed slightly between 1970 and 1990. Industrialization, the well-trodden path to the achievement of higher standards of living and expanded economic development, remained a distant goal for many developing countries.

18. The Ministers noted that threats to the environment were a common concern. They stated that all countries should take effective action to protect and enhance the environment in accordance with their responsibilities and respective capacities. In this regard, the Ministers confirmed that in developing strategies to secure agreement on, and commitments by, Governments on major environmental issues, it has been recognized that:

(a) Because the greater part of current emission of pollution into the environment originates in developed countries, these countries bear the main responsibility for combating such pollution;

(b) International cooperation between all countries, and in particular between developed and developing countries, is essential to acquiring and using relevant scientific information and environmentally sound technologies. Industrialized countries with significant experience in pollution prevention, cleaner production methods and pollution control technologies are encouraged to promote industrial pollution prevention and management world wide. Economic well-being is essential for achieving sustainable development and minimizing the degradation of the environment concomitant with such growth. Ministers called on Governments and industry to cooperate at the local, national and regional levels in using existing and, where necessary, establishing new mechanisms that promote pollution prevention, waste minimization, cleaner production, energy efficiency and rational use of natural resources and in making these techniques and technologies available, particularly to developing countries. This would entail the mobilization of financial resources and enhanced technical cooperation in particular with developing countries, at the bilateral and multilateral levels. However, it was also recognized that new and additional financial resources will have to be channelled to developing countries in order to ensure their full participation in global efforts for environmental protection.

19. Ministers recognized that economic, social and environmental elements of the decision-making process should be fully integrated, and that there was a fundamental mutual dependence between economic growth and environmental protection. Ministers noted that sustained economic growth and effective environmental protection are closely interlinked and should not be looked upon as competitive policy objectives.

20. The continuing deterioration of the global environment is closely related to the unsustainable pattern of production and consumption in particular in industrialized countries. In developing countries, environmental degradation is closely related to poverty and underdevelopment, as well as demographic patterns and pressures. Promotion of economic and social development is therefore essential for the protection of the environment.

21. The Ministers noted with concern the financial and technological constraints facing the developing countries in realizing the desired ecologically sustainable industrial development.

22. The Conference was held at the time when economic reforms to strengthen the private sector and harness market forces in support of economic development were being carried out in a number of countries. The need was recognized for economic instruments to supplement public regulations. Ministers stressed that market-oriented instruments could play an increasing role in achieving ESID, in particular by internalizing environment considerations. Assistance should be provided upon request, by donors and international organizations, to countries that needed to develop such instruments and to administer them.

23. The Ministers called for new approaches to industrialization that would allow industry to contribute to economic and social benefits for present generations without compromising the ability of future generations to meet their own needs, and without impairing basic ecological processes. These new approaches do not imply in any way encroachment upon national sovereignty. States have, in accordance with the Charter of the United Nations and the applicable principles of international law, the sovereign right to exploit their own resources pursuant to their environmental policies. This also reaffirms their responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States. Those new approaches would enhance economic development over time through the efficient and rational management of both renewable and non-renewable resources while aiming at minimizing waste. They would differ from country to country, depending on the resource endowments, the stage of development and other economic and social characteristics as well as the assimilative capacity of the ecosystem.

24. The Ministers agreed that the reduction of pollution intensity across all media within industry, through cleaner production, was the key to achieving ESID. Thus, the development of technology to promote cleaner production should be enhanced. The objective of cleaner production, with its focus on source reduction, waste minimization, energy efficiency and low-waste and non-waste technology, is to prevent or minimize, in the most cost-efficient manner, the short- and long-term risks to humans and the environment. Cleaner production would require a management approach that, inter alia:

(a) Assigned priority to the efficient use of resources, materials substitution and product reformulation, process modification and equipment redesign to lower waste technologies, and recycling and reuse as the primary options for pollution prevention and increased profitability;

(b) Utilized safe and environmentally sound processes, technologies and substances combined with efficient operating procedures;

(c) Assigned clear responsibility and incentives for pollution prevention and control, in the context of a regulatory framework that establishes achievable environmental goals and that provides industry with flexibility in the choice of response actions.

25. Ministers recognized the importance of providing women with knowledge on ESID, as well as access to the necessary measures to promote it.

26. The Ministers agreed to support action to overcome barriers to the achievement of ESID. Among those barriers are the difficulties of implementing policies both in the North and the South that would bring about a transition to ESID. Industry everywhere needed to re-examine its attitudes on pollution prevention, cleaner production and environmentally friendly products.

B. INDUSTRY INITIATIVES IN ACHIEVING ESID

27. The Ministers recognized that industry and industrial institutions had to play a central role in the transition to ESID. While Governments can assist, regulate and control that transition, it is essential that industry acts in accordance with the principles implied by ESID. The relevant organizations and institutions should promote managerial practices and technologies based on the principles of sustainability.

28. The Ministers agreed that, in order to achieve ESID, industry initiatives should include the following objectives:

(a) Adoption of pollution prevention, the approach that prevents pollution at the source in products and manufacturing processes rather than removing it after it has been created;

(b) Integration of environmental awareness and responsibility at all management levels, taking into account careful analysis of relative risks, introduction of waste minimization and environmental compliance auditing, establishment of emergency, risk and safety management systems, as well as training programmes;

(c) Adherence to environmental codes of conduct, including voluntary ones, for industrial investment and production;

(d) Increase of R and D activities with emphasis on cleaner production technologies, giving priority to technologies that offer potential for improved efficiency and reduced pollution; and provide training facilities to developing countries for this purpose;

(e) Consideration, where feasible, of the use of substitute materials and product reformulations, process modifications and equipment redesigns, renewable sources of energy and raw materials, recycling and reuse of waste and scrap materials;

(f) Assumption of a "cradle-to-grave" assessment approach to industrial products and projects;

(g) Application of cleaner industrial production processes and more rational use of natural resources;

(h) Development, transfer and adaptation of environmentally sound technologies, know-how and skills to meet the needs of other countries, in particular developing countries, and mobilization of financial resources and provision of human resources for this purpose;

(i) Encouragement of industry to provide information on environmentally sound management and energy conservation.

The foregoing objectives could be facilitated by regular exchanges of experiences in the context of long-term programmes developed by industry.

29. The Ministers recognized that the Economic and Social Council, at its second regular session of 1991, had addressed ways to encourage and mobilize industrial enterprises, including transnational corporations, to cooperate in efforts to protect and enhance the environment in all countries. In that regard, the Council adopted resolution E/1991/55, requesting, inter alia, the preparation of action-oriented and practicable recommendations for consideration by the Commission on Transnational Corporations and by the Preparatory Committee of the United Nations Conference on Environment and Development.

30. The Ministers recognized that many transnational companies and investors involved in international joint ventures or in the export of manufacturing processes implement ESID and apply general standards of environmental responsibility to their foreign operations which are fully consistent with those used in their home countries and in compliance with the laws and regulations of host countries. These standards should not be applied on a discriminatory basis. Ministers encouraged all companies to adopt this policy and subscribe to a rational and precautionary approach to anticipating and preventing the causes of serious or irreversible environmental degradation consistent with scientific and technical understanding and the economical use of resources.

31. The Ministers encouraged non-governmental organizations representing all the parties involved in the industrial process, including industrial federations, trade unions, and consumers and environmental groups, to carry out and participate in activities relevant to ESID.

32. UNIDO undertook five case studies for the preparation of the Conference to illustrate the scope for ESID. These case studies covered pulp and paper, leather industry, alumina industry, plastics and plastics waste recycling, and phosphate fertilizers. The studies presented a number of problems related to unsustainable production processes and suggested measures to solve them. Ministers emphasized the importance of ensuring close cooperation between industry, Governments and international organizations in solving those problems.

C. GOVERNMENT INITIATIVES IN ACHIEVING ESID

33. The Ministers agreed that Governments could:

(a) Review the environmental impact of current and planned policies, regulations and institutional infrastructure that affect industry and environment with a view to contributing to the transition to ESID through appropriate policies and measures;

(b) Review the environmental impact of current and planned policies and build in the environmental concerns as an integrated part in such policies and strategies;

(c) Design suitable methods and tools for quantification and valuation of natural and environmental resources used by industry;

(d) Establish new, or strengthen existing procedures for reviewing industrial projects with potentially significant environmental effects. Similar procedures should be applied for reviewing risks associated with products. The evaluation and assessment procedures should be based on a cradle-to-grave approach and continue during and after completion of projects. The evaluation and assessment procedures should be supported by internationally recognized ecological guidelines and indicators where these exist;

(e) Apply, with due consideration for the economic and social conditions in specific countries, a balanced mix of regulatory and economic instruments, including the internalization of externalities in price calculations, to reach the objectives of industrial development and environmental protection;

(f) Design policies based on the "polluter pays" principle, bearing in mind the need to internalize the cost of environment protection in price calculations, and to apply a precautionary approach and the principle of economic efficiency when undertaking or promoting investments. Inclusion of the cost for pollution abatement in entrepreneurial calculations would thus be a useful approach governing the use of economic instruments and help to achieve a better allocation of resources in the pursuit of environmentally sustainable industrial development;

(g) Implement schemes for increasing public awareness, particularly in the younger generation, of the necessity for ESID and the responsibility of individual enterprises, managers, engineers, workers and other members of staff in that respect;

(h) Give active encouragement to ESID through research, development, acquisition and transfer of techniques and technologies, as well as efficient utilization of existing relevant technologies in the public and private sectors, and through public and private partnerships while ensuring occupational health and safety;

(i) Promote technical and managerial training and education that incorporate ESID in both informal and formal sectors;

(j) Create an adequate institutional framework to stimulate environmental policies such as regulations, standardization, monitoring and control of the industrial environment;

(k) Promote ESID through environmental education and the participation by the general public and non-governmental organizations, such as industrial federations, employees associations, community-based groups, consumers, women's, environmental and developmental organizations;

(l) Support exchanges of information and experience on ESID among all countries in particular between industrialized and developing countries;

(m) Provide access, on preferential conditions, to financing sources to small- and medium-scale enterprises in support of ESID-oriented restructuring and modernization;

(n) Incorporate the principal elements of their policy in programmes that extend over several years. These programmes should be made public.

D. INTERNATIONAL COOPERATION IN ACHIEVING ESID

34. The Ministers called upon Governments to enhance international cooperation in mobilizing financial resources for achieving ESID. The mobilization of financial resources is of vital importance to ESID, as well as to alleviating environmental problems in general. International sources of financing, particularly the development assistance programmes of developed countries, play a key role in this respect.

35. Noting that the transfer of techniques and technologies is one of the keys to the adaptation and absorption of pollution prevention techniques and the cleaner production processes by industrial firms, the Ministers agreed to encourage international cooperation in the transfer of those techniques, technologies and processes, and the requisite information, skills and know-how from industrialized to other countries, in particular developing countries, as well as the means necessary to develop infrastructure and policies to support them. The Ministers recalled United Nations General Assembly resolution 44/228, section I, paragraph 15 (m), which decided that UNCED should have as an objective the examining of effective modalities for favourable access to, and transfer of, environmentally sound technologies, in particular to the developing countries, including on concessional and preferential terms. The Ministers look forward to the results of that examination.

36. The Ministers invited Governments to seek international cooperation in addressing concerns about linkages between the environment and trade in manufactured goods. While the pursuit of the objectives of trade liberalization and environmental protection are in principle compatible, some trade practices may give rise to certain environmental concerns, and some environmental actions may adversely affect international trade flows. The Ministers also noted that improved access to markets in general - through reduction and possible elimination of tariffs and elimination of non-tariff barriers to trade - would improve the possibilities of all countries, particularly of developing countries, to finance the introduction of ESID-related technologies, and could have important foreign exchange implications.

37. Noting that financial and technological constraints are among the key obstacles facing many countries, in particular developing countries, in achieving ESID, the Ministers acknowledged that the industrialized countries should create a climate conducive to enabling those countries to have access to appropriate ESID techniques and technologies and to financial resources on concessional and non-concessional terms, as appropriate.

38. Ministers called for the need to coordinate efforts between UNIDO and all other United Nations institutions and organizations that deal with environmental issues, in order to be more efficient and effective, and avoid duplication in the pursuit of ESID.

39. Ministers recognized the critical situation prevailing in least developed countries and called for special measures in favour of those countries in support of their ESID policies and programmes.

E. FUTURE ACTIVITIES OF UNIDO

40. Ministers recognized that ESID can both reduce environmental problems and enhance industrial efficiency, and invited the fourth session of the General Conference of UNIDO to express its support for UNIDO to continue working on the best options to achieve ESID, in order to present them as a valuable contribution to be taken into account at the Fourth Preparatory Committee of the United Nations Conference on Environment and Development, which will take place in March 1992, and for submission at the UNCED conference in June 1992.

41. Ministers invited UNIDO to submit proposals incorporating the views expressed at the meeting in Copenhagen, and to make concrete suggestions to harmonize its activities, in the short, medium and long term, with the concept of ESID. These suggestions should be submitted for consideration to the policy-making bodies of the Organization, taking into account the mandates, recommendations and guidelines of UNCED. In order to improve UNIDO's capabilities to implement the conclusions and recommendations of the ESID Conference, the Ministers further call upon Member countries to continue to make resources available for sustainable industrial development through the UNIDO Environment Programme.

42. Action by UNIDO, within available regular budget resources and additional voluntary contributions, if any, could make a significant contribution to the implementation of ESID. Because environmental management often involves complex issues and requires specialized skills, UNIDO would need to work in cooperation with other organs, organizations and programmes of the United Nations system to ensure the broadest possible effort. In particular, UNIDO should work closely with the United Nations Environment Programme, especially with its Industry and Environment Office, in such activities as information exchange and training.

43. UNIDO should lend its support, on a coordinated basis, to the activities of other organizations active in this field, in particular United Nations regional commissions, in implementing ESID at the regional level. Further, UNIDO should promote the establishment and support of the necessary institutional framework and should work in close cooperation with national institutions in implementing ESID.

44. The following were some major directions for possible UNIDO action in achieving ESID:

(a) Assisting developing countries, upon request, in building the technical and scientific institutional capacity to develop, absorb and diffuse pollution prevention techniques and cleaner production processes essential to making the transition to ESID. This could be done by:

(i) Demonstrating the financial and economic advantages and environmental benefits of ESID by working cooperatively with industry and other technical experts, and with Governments, to undertake a programme of site-specific, country case studies;

(ii) Providing technical support for the design, establishment, operation, evaluation and monitoring of pollution prevention techniques and cleaner production processes and technologies;

(iii) Assisting demonstration and training centres at new or existing industrial facilities, and providing support to centres of excellence;

(b) Assisting developing countries in the implementation of international environmental conventions and protocols related to industrial activities by:

(i) Providing technical assistance to those countries to identify and implement the actions needed;

(ii) Helping those countries to locate expertise and funding for projects that contribute to the implementation of those conventions and protocols;

(c) Assisting developing countries in determining the environmental soundness of industrial technologies by:

(i) Preparing guidelines on environmentally sound industrial practice for selected sectors;

(ii) Promoting, in selected sectors, technical procedures to evaluate and to test processes, products and services;

(iii) Providing assistance for the development of assessment techniques for the identification and measurement of environmental impact;

(d) Assisting developing countries in integrating environmental considerations into their industrial strategies and policies by:

(i) Identifying sectoral and subsectoral priorities for environmentally sound industrial activities;

(ii) Specifying the techniques available to rehabilitate existing industries so that they could operate in an ecologically sustainable manner, assessing the costs of such a transition and estimating a time-frame for achieving it;

(e) Assisting developing countries in identifying appropriate, including new, financial resources, where possible on concessional terms, that would enable them to take necessary steps to achieve ESID;

(f) Assisting other countries, upon request, in achieving ESID in accordance with the provisions of the UNIDO Constitution and relevant decisions of the General Conference and Industrial Development Board;

(g) Strengthening its existing database and its capacity to coordinate the dissemination of technical and policy information on ESID, inter alia, by cooperating with the United Nations Environment Programme in its work on the International Cleaner Production Clearinghouse (ICPIC).

In implementing its programmes and projects UNIDO should establish and/or strengthen internal procedures for appraisal and approval of activities that ensure compatibility with the concept of ESID.

Agenda item 6: Reports from the symposiums

45. Drawing on the case studies referred to in paragraph 32 above, the Ministers took note with appreciation of the conclusions formulated during a series of technical symposiums that were held concurrently with the plenary meetings of the Conference. Those conclusions are listed below. The technical symposiums covered five industrial subsectors - alumina, leather, phosphate fertilizers, plastics and plastics waste recycling, and pulp and paper. Discussion in the symposiums reflected the issue of ecologically sustainable industrial development addressed in the plenary. Specific examples were provided of the implications of ESID for each subsector.

46. Each symposium was led by a panel consisting of a UNIDO sectoral expert, an independent international expert and a representative of industry. An NGO representative participated in the panels of the five symposiums. The moderator of each panel was a representative of an IGO. After the initial presentations, detailed discussions took place on the specific problems, and their possible solutions, in addressing the tenets of ESID.

47. The five symposiums arrived at various conclusions relevant to the sectors covered. One such conclusion pertained to the need for subsector-specific technical cooperation efforts, the exchange of information and, in some cases, support of significant research efforts, in order

to assist those subsectors in developing countries to meet ESID requirements. A second conclusion was that ESID could be supported by both short-term, low-cost adjustments as well as by longer-term, higher-cost solutions offered by newer technologies. A third conclusion was that meeting ESID requirements would neccessitate some structural changes affecting the subsector as a whole, as well as measures to reduce specific pollutants from individual industrial plants. Examples of such structural changes were: recycling in the pulp and paper, plastics and aluminium industries; provision of alternative processes to the leather tanning industry; and changes in agricultural practices to reduce the need for fertilizers. A fourth conclusion was that industry bears a major responsibility for the cradle-to-grave management of its products, including support for the above-mentioned structural changes.

48. It was agreed by participants that the exchange of views in the individual symposiums, in addition to clarifying the issues relating to ecologically sustainable industrial development for the specific subsectors, had suggested important roles for different actors. The discussion also highlighted a number of ways in which UNIDO, based on its accumulated experience, could support such efforts at both the policy, informational and operational levels.

49. More detailed coverage of the results of the symposiums is contained in annex I to the present report.

Agenda item 7: Adoption of the report

50. The report of the Conference was presented by the Vice-President, Mr. M. Malianga (Zimbabwe) on behalf of the Rapporteur, and was adopted at the final plenary session with the understanding that the Secretariat was authorized to finalize it in the light of amendments.

Agenda item 8: Closure of the Conference

51. The Ministers expressed their appreciation to the Government of Denmark for its hospitality and cooperation in facilitating the work of the Conference. In this connection, the Ministers noted with appreciation the contributions by those countries who, through the Industrial Development Fund, made it possible to convene the Conference.

52. Statements of appreciation were made by the representatives of Argentina, India, Mexico, Turkey, Uganda, United Republic of Tanzania, United States of America and by the representative of Vor Falles Fremtid, on behalf of the NGOs attending the Conference.

53. The meeting was closed at 12 noon, 18 October 1991.

Minimizing waste in Itauna

In the Santanes textile plant in Itauna, Minas Gerais, Brazil, the mercerization process, where cotton thread is treated with alkali to give greater strength, was modified. This reduces the consumption of caustic soda from 180 to 140 tons per month, lessens the pollution load and saves the company 3 million cruzados novos every year.

UNIDO has been implementing a programme for upgrading the Brazilian textile industry since 1988, with funding from UNDP and the Government of Brazil.

The textile industry in Brazil is an example of a sector where environmental improvements yield considerable economic benefits as well. The Santanes upgrading results from recommendations made during the first UNIDO expert mission in 1989. Later the Center of Technology of the Chemical and Textile Industry (CERTIQT) in Rio de Janeiro became the focal point for the programme. UNIDO carried out a survey of textile effluents for CERTIQT recently. Nine textile plants were visited and, in all of them, profitable recovery and reuse opportunities were identified - caustic recovery from mercerization, reuse of water from scouring and bleaching, recovery of indigo dye from waste water, reuse of dye baths and automatic control of processes to reduce water and fuel consumption.

ISSUES IN SUPPORT OF ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

CONTENTS

INTRODUCTION

1. The General Assembly, in its resolution 44/228, section I, decided to convene a United Nations Conference on Environment and Development, to be held at Rio de Janeiro, Brazil, from 1 to 12 June 1992, to mark the twentieth anniversary of the United Nations Conference on the Human Environment, held at Stockholm from 5 to 16 June 1972. The United Nations Conference on Environment and Development will offer Governments an opportunity to seek consensus on measures relating to global, regional and national environmental and development issues.

2. The UNIDO environment programme (see IDB.6/3, paragraphs 3-28), approved by the Industrial Development Board in its decision IDB.6/Dec.7, focuses primarily on enhancing the Organization's capacities in rendering industry-related assistance with regard to the environment; assisting developing countries in formulating industry-related environmental policies and legislation; promoting clean, low-waste, energy-efficient and recycling or reuse technologies; and providing technical assistance in pollution abatement. The Industrial Development Board, also in its decision IDB.6/Dec.7 on the UNIDO environment programme, requested the Director-General to report to the General Conference at its fourth session on the implementation of that decision, including the UNIDO contribution to the United Nations Conference on Environment and Development.

3. As part of its contribution to preparations for the United Nations Conference on Environment and Development, UNIDO called for a Conference on Ecologically Sustainable Industrial Development (ESID), to be held at Copenhagen from 14 to 18 October 1991, to assist Governments, particularly those of developing countries, in understanding ESID-related requirements and in formulating appropriate policies and strategies. After reporting the results to the General Conference at its fourth session in November 1991, the conclusions and recommendations of the Conference on ESID will be presented to the United Nations Conference on Environment and Development.

4. The environmental dimension of industrialization plays an important role in UNIDO activities and will do so in the future. UNIDO has a long history of providing technical assistance to developing countries. Environmental aspects and impacts are increasingly being taken into account in the day-to-day project operations of UNIDO. The Organization's experience is quite extensive, covering most sectors of industry and the associated aspects of technology, management, design and training. The Conference on ESID, however, offers the first opportunity for member States to deal specifically with issues related to industry and environment at the ministerial level. UNIDO draws its mandate in this context from General Assembly resolutions 42/184, 42/186, 42/187, 43/53, 43/196 and 44/228; General Conference decision GC.2/Dec.11 and resolution GC.3/Res.16; and Industrial Development Board decisions IDB.4/Dec.19 and IDB.6/Dec.7, as well as documents IDB.4/16, IDB.6/3, GC.3/17 and GC.3/32.

5. Industry plays a critical role in economic development and in the enhancement of the economic welfare of populations. By transforming raw materials through processing, industry produces a wide range of consumer goods and, more importantly, intermediate and capital goods for all sectors of the economy. It generates substantial employment in producing consumer and investment goods, and it is the most dynamic sector of the economy in terms of inducing and disseminating technological change.

6. Global trends in industrialization over the past 20 years reveal that significant progress has been achieved in some developing regions and countries. World industrial output has grown at an annual rate of 3.6 per cent, compared with an annual population growth rate of 1.8 per cent. Noteworthy gains have occurred in some regions, particularly East Asia and South-East Asia, whereas in others, particularly Africa and Latin America, industrial growth has been low compared with population growth. In the period 1970-1990, developing countries increased their share in world industrial output from 9.3 per cent to 13.2 per cent. Most of that increase, however, occurred in the period 1970-1980.

7. Since 1970, industry, in spite of intensive efforts to reduce pollution, has continued to contribute to deterioration in the environment. At the national level, problems related to air, water and land quality persist in many areas. At the regional level, acid deposition and the dispersal of toxic chemicals, largely due to industrial activity, are causing serious problems. At the global level, new environmental problems, including those arising from greenhouse gas emissions and ozone depletion, have emerged; industry, which accounts for about one third of the world's primary energy consumption, has contributed substantially to those problems.

8. A significant amount of pollution today can be traced back to the industrialization that has taken place over the past 150 years. The traditional pattern of social and economic development in industrialized countries accounts for a major share of today's global and regional problems of concern. Thus, industrialized countries bear a special responsibility for responding to those problems. No country, however, can afford to ignore the contribution of industrial activity to environmental deterioration, particularly in the light of the industrial growth that is expected in developing countries in the years to come. If developing countries are to identify, manage and implement environmental programmes, specifically those related to the industrial sector, while maintaining their development momentum, greater emphasis should be placed on cooperation between developed and developing countries. Integrating the concept of "sustainability" in the development process will only be possible if industry, labour, consumers, Governments and international organizations are willing to work together more closely at the national, regional and global levels.

I. THE CONCEPT OF ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

9. A definition of ESID is essential to considering how best to achieve it and to identifying incentives that could contribute to its achievement. One potential definition is the one adopted by the Governing Council of the United Nations Environment Programme (UNEP) in 1989 - and based on the report of the World Commission on Environment and Development entitled "Our Common Future" (A/42/427, annex) - stating that sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs and does not imply in any way encroachment upon national sovereignty. Following from that definition, a definition of ESID is as follows: patterns of industrialization that enhance the contribution of industry to economic and social benefits for present and future generations without impairing basic ecological processes. These new patterns would increase economic development over time while efficiently utilizing non-renewable resources, conserving renewable resources and not exceeding the waste assimilative capacities of ecosystems; and they would differ depending on a country's resource endowments and stage of economic development.

10. Ecological processes at risk are chose threatened by the pollution of air water and soil, the destruction or alteration of habitat, the loss of wild species, and fundamental changes in geochemical, hydrological and climatic cycles. Furthermore, human health and safety are major concerns at all times.

11. To contribute to the achievement of ESID, the following objectives should be taken into account:

(a) Use of non-renewable resources at a rate guided by the availability of substitutes, use of renewable resources at a rate limited to their natural or managed regeneration rates, and the dispersion of industrial wastes at a rate limited to the assimilative capacities of ecosystems, thus preventing irreversible effects on basic life-support systems (eco-capacity);

(b) Adherence to the precautionary approach, which calls for environmental measures that prevent environmental degradation and attack its causes, thus anticipating threats of serious or irreversible damage (precaution);

(c) Development of procedures for accident prevention, thus reducing the risks of and potential losses associated with environmental emergencies (anticipation);

(d) Prevention of pollution at its source in products and manufacturing processes rather than removing it after it has been created (prevention);

(e) Minimization of resource consumption per unit of output and waste per unit of output, thus ensuring efficient use of man-made and natural capital (efficiency);

(f) Provision of opportunities for all countries to participate in the industrialization process, to benefit from the wealth generated by industrial activities and to apply the same principles of equity between genders and between present and future generations (equity).

II. BARRIERS TO ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

12. Common to both developed and developing countries are barriers to the achievement of ESID. These encompass information gaps and deficiencies, scientific, technological, professional and related institutional capacities to support the process of transition to ESID, as well as political and economic obstacles to its implementation.

13. Information deficiencies include limitations of data on the nature and extent of environmental degradation (physical indicators of resource depletion, as well as air, water and land pollution); limited understanding of the proximate and underlying causes of, and hence feasible remedies for, environmental degradation; and insufficient measurement of economic losses resulting from environmental degradation.

14. Most of the problems cited above may be more acute in some developing countries where government activity is constrained by urgent, short-term financial needs. The gathering and dissemination of information and applied research do not receive sufficient attention. Consequently, Governments have inadequate information on the nature, magnitude, causes and consequences of environmental degradation; furthermore, because of low economic and

technological capacities of their countries, they often lack access to non-commercial and non-profit technical information to deal adequately with pollution-related problems.

15. Obstacles to ESID-related measures are numerous. Heading the list of such obstacles are conflicts between short-term economic costs and long-term economic benefits of environmental protection. Regulatory and monitoring capacity and skilled personnel may not be sufficient for dealing with new problems. Small- and medium-scale industries have limited information and lack the skills and capital needed to implement cleaner production processes. Political and social constraints often limit the setting of economically appropriate prices for water, energy and raw materials. States may ignore the consequences of industrial activity that result in damage being done outside of their borders. Finally, the poor, disadvantaged and vulnerable tend to suffer most from environmental degradation, but lack the political influence required to bring about the introduction of remedial measures.

16. Obstacles to the implementation of ESID-related measures are intensified in developing countries. Weak institutional capacity, particularly the ability to implement and coordinate programmes, and shortages of skilled personnel are major problems in developing countries. Even if existing industry wanted to invest in more environmentally sound technologies, it would often be faced with financial constraints. The scarcity and high cost of capital may preclude importing those technologies, even if the investments are economically justified. Lastly, a sizeable portion of the population lacks the awareness, education and experience needed to deal with environmental problems, and the few non-governmental organizations (NGOs) that are involved in such matters lack political influence.

17. More importantly, developing countries are faced with particular difficulties in achieving ESID. One barrier can be in part traced to their indebtedness, which results in shortages of capital needed to finance cleaner production processes. Another is their limited capacity to absorb cleaner production practices, which is attributable in part to their lack of technical and scientific capacity. A third is the potential risk of new non-tariff barriers emerging as a side-effect of new environmental measures that, in effect, close markets to exports from developing countries. Keeping markets open to manufactured products from developing countries will provide such countries with better conditions for the repayment of debts to developed countries.

III. INDUSTRY INITIATIVES IN ACHIEVING ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

18. Through the International Chamber of Commerce and its international and national associations, industry has declared its support for principles of sustainable development. Industry regards sustainable development as a goal that requires real economic growth, since only such growth can create the economic and technical capacity to solve environmental problems. On several occasions, most recently at the Second World Industry Conference on Environmental Management, held at Rotterdam from 10 to 12 April 1991, industry declared its willingness to work towards a continuous improvement of environmental performance.

19. It is in industry's own interest to adopt a course of action leading to ESID. Industry can maximize profits by increasing efficiency while at the same time maintaining environmental concerns. Pollution prevention is more environmentally effective, technically sound and economical than conventional controls. Industry can develop and utilize clean production processes and produce "green" products. The full cooperation of all concerned is needed to avoid irreversible adverse effects on humans or development.

20. The trend towards using greater transparency as a means of securing public confidence in and support for operations has been observed in several sectors. Industry's strategy for ESID might include the following elements:

(a) Adoption of pollution prevention, an approach that prevents pollution at its source in products and manufacturing processes rather than removing it after it has been created;

(b) Integration of environmental responsibility in decision-making at all management levels; introduction of waste minimization and environmental compliance auditing; establishment of emergency, risk and safety management systems; and establishment of training programmes;

(c) Adherence to voluntary environmental codes of conduct for industrial investment and production;

(d) Increase of research and development activities with emphasis on cleaner production technologies, giving priority to technologies that offer potential for improved efficiency and reduced pollution; and provision of training facilities to developing countries for that purpose;

(e) Consideration, where feasible, of the use of substitute materials and product reformulation, process modification and redesigning of equipment, renewable sources of energy and raw materials, recycling and reuse of waste materials;

(f) Assumption of a "cradle-to-grave" approach to industrial products;

(g) Application of cleaner industrial production processes and more rational use of natural resources;

(h) Transfer and adaptation of environmentally sound technologies, know-how and skills to meet the needs of developing countries and mobilization of financial resources for this purpose;

(i) Encouragement of large-scale industry to provide information on environmentally sound management and energy conservation.

21. Principles for achieving ESID have been embodied in the Criteria for Sustainable Development Management prepared by the United Nations Centre on Transnational Corporations. The following elements of the criteria are also embodied in the Business Charter for Sustainable Development, adopted by the Executive Board of the International Chamber of Commerce at its sixty-fourth session on 27 November 1990: corporate priority, integrated management, process of improvement, employee education, prior assessment, products and services, customer advice, facilities and operations, research, precautionary approach, contractors and suppliers, emergency preparedness, transfer of technology, contributing to the common effort, openness to concerns, compliance and reporting.

22. Industrial associations and chambers of commerce could promote environmental practices that go beyond the minimum legal requirements and regulations. They could also organize training programmes, advise public authorities and facilitate the sharing of non-proprietary information and technology. Similarly, the environmental issues pursued by trade unions, consumer associations, women's groups and community groups working with industry and other organizations could have a major effect on how industry develops its strategy.

23. The general arguments on why industry would follow a course leading to ESID also apply to transnational corporations (TNCs), which have a particular role to play. TNCs that have been establishing operations in developing countries should apply standards of environmental responsibility to their foreign operations and should at least apply standards consistent with those used in their home countries and in compliance with the laws and regulations of host countries. Furthermore, open operations and rapid communication put the global image of a corporation at risk if an environmental incident occurs.

24. Important issues to be considered include the following:

(a) How can industry be assisted and encouraged to follow a course of action leading to ESID using a system of incentives and measures?

(b) How should such incentives and measures to assist and encourage industry be international in scope?

(c) How can voluntary action by industry to achieve ESID be assessed and communicated?

(d) How can small- and medium-scale enterprises best be assisted in achieving ESID?

IV. GOVERNMENT INITIATIVES IN ACHIEVING ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

25. If, through imperfections, the market fails to deal adequately with the environment, government initiatives and intervention may be required to achieve ESID. Such failures of the market to deal with the environment arise when the interests of industry are not consistent with those of society. The achievement of ESID thus requires the assertion of environmental concerns through industrial policies and strategies adopted by Governments.

26. Governments need an industrial policy that supports the development, promotion and diffusion of pollution prevention and cleaner production processes. Governments should develop a transparent public information policy concerning the environment and should support education, training and research programmes to raise public capabilities and awareness.

27. Government intervention may be divided into two types: regulations and market-oriented incentives. Regulations involve a complex mixture of standards, permits, monitoring and enforcement that, taken together, are frequently termed a "command-and-control" approach. In developed countries, noteworthy successes have been achieved using this approach. But regulations alone will not be efficient in achieving ESID. In recent years this approach has been augmented with market measures and voluntary measures, such as the use of economic incentives, pollution prevention, waste minimization and cleaner production technologies.

28. One of the conditions for maximum efficiency (both traditional economic efficiency and environmental efficiency) is that prices for products and services must reflect their full social and economic costs. It is not always possible to accurately determine those costs. Market-based economic instruments, such as taxes, fees and tradeable permits, however, give industry a direct financial incentive to reduce pollutant discharges in the most cost-effective manner. Combining a mixture of market-based incentives with a regulatory or pollution prevention approach has cost-saving potential. Flexibility on the part of Governments in allowing industry to choose the timing of pollutant reductions and the methods to be used to achieve such reductions may result in industry adopting cleaner production processes that go beyond meeting traditional environmental standards.

29. An important factor to be considered is the relationship between environmental policies and economic and social policies. Governments need to be aware of, for example, the repercussions of tax and subsidy policies in general on the use of resources and on the environment. They need to ensure that such policies, aimed perhaps at export promotion, do not encourage behaviour that would have an adverse effect on the environment.

30. In addition to strict environmental considerations, industry is subject to complex considerations in areas such as occupational safety, health, planning and economic zoning, wildlife and marine life protection and conservation.

31. Environmental intervention requires institutional capability, which is often lacking, particularly in developing countries. Consequently, simpler policy instruments, such as tax policy, resource-pricing and withdrawal of subsidies, may be needed in order to achieve economic and environmental objectives simultaneously.

32. Community associations, women's organizations and NGOs have in many instances played an important role in increasing public awareness and behaviour with respect to environmental questions. A Government designing an ESID-oriented policy should consider proposals and ideas relevant to manufacturing industry that have been suggested by such associations and organizations.

33. The following issues need to be considered in this context:

(a) How can environmental considerations be integrated in the formulation of industrial policies and strategies from the very outset instead of being taken up later when the planning or implementation process is already at an advanced stage?

(b) What is the appropriate mixture of policy, regulatory and economic incentives, given the dual objectives of maximizing the productive performance of the industrial sector and protecting the environment?

V. INTERNATIONAL COOPERATION IN ACHIEVING ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

34. Since the convening of the United Nations Conference on the Human Environment in 1972, the international community has undertaken several initiatives, particularly in the 1980s, that constitute important steps towards achieving ESID. The World Commission on Environment and Development, in its report entitled "Our Common Future" (A/42/427, annex), emphasized the

need for all countries to cooperate in pursuing economic, social and environmental objectives with a view to achieving sustainable development. The Environmental Perspective to the Year 2000 and Beyond, prepared by UNEP for its Governing Council and contained in General Assembly resolution 42/186, annex, offers a broad framework for guiding national action on and international cooperation in policies and programmes aimed at achieving ESID. Other organizations such as the Organisation for Economic Co-operation and Development have also taken steps to address those issues.

35. The international community has made efforts to resolve global and regional environmental problems resulting from industrial activities. Noteworthy global efforts include the Vienna Convention for the Protection of the Ozone Layer, adopted on 22 March 1985; the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted in September 1987 and amended in June 1991; the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (UNEP/JG.80/3); the Voluntary Code of Conduct for the Release of Organisms into the Environment, prepared by the UNIDO Secretariat for the Informal UNIDO/UNEP/WHO/FAO Working Group on Biosafety; and the efforts of the Intergovernmental Panel on Climate Change. Among numerous regional efforts are marine environment protection programmes; guidelines on trade in chemicals; and conventions on dumping and on the transboundary movement of air pollutants. By supporting new initiatives, the Interim Multilateral Ozone Fund and the Global Environment Facility, developed countries have recognized that developing countries need additional financial resources to mitigate specific environmental problems.

36. Issues related to international cooperation fall into three areas of critical importance to the achievement of ESID, each of which entails regional and global cooperation of both a North-South and a South-South nature, as given in the paragraphs below.

37. Financial resources. The mobilization of financial resources is vital to ESID, as well as to alleviating environmental problems in general, and international sources of financing, particularly the development assistance programmes of developed countries, play a key role. Public and private sources also contribute to investment in environmental protection, particularly as progress is made on debt relief and establishment of meaningful societal priorities.

38. Technology cooperation. The adaptation and absorption of pollution prevention techniques and cleaner production processes by industrial firms are key ESID issues. Many of those techniques and processes and the information, skills and know-how associated with their use are in developed countries, particularly in corporations. Ways must be found to ensure their efficient transfer to developing countries on concessional terms.

39. Trade and environment. Policies on trade in manufactured goods may have an adverse impact on environmental concerns and environmental policies may alter such trade patterns. Issues relating to protectionist policies, product and process standards and specifications, intellectual property rights, foreign direct investment flows, and structural change affect technology cooperation and need to be dealt with at the international level.

VI. FUTURE ACTIVITIES OF UNIDO RELATED TO ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

40. UNIDO needs to develop a comprehensive programme for the promotion of ESID that will build on its strengths and will constitute a logical extension of the capabilities and experience it has acquired during the implementation of its environment programme. The relationship of UNIDO with Governments, its years of experience in industrial development in developing countries, its network of experts and field offices, and its role within the United Nations system in promoting industrial development provide the foundation for its approach to and involvement in ESID. In developing such a programme, recommendations and guidelines from the United Nations Conference on Environment and Development should also be taken into account.

41. The UNIDO environment programme provides broad guidelines and a basis that will enable the Organization to assist developing countries in making the transition to ESID. It requires UNIDO to improve its capacity to render ESID-focused technical cooperation, to assist developing countries in formulating ESID-related industrial policy and to increase its efforts in promoting both cleaner production and pollution abatement. These programme components are being implemented by providing internal training, following modified project design guidelines and integrating ESID-related components into technical cooperation projects. The latter contribute to ESID at the enterprise, sectoral and national policy levels. For example, UNIDO has acquired a wealth of experience in advising managers and others at the plant level on improving operating procedures, thereby helping them not only to achieve greater operational efficiency and product yields, but also to reduce waste that might otherwise be discharged directly into the environment.

42. The concept of ESID comprises many elements. An important issue is how UNIDO can modify and expand its environment programme to further the objectives of ESID and its efforts to assist developing countries in achieving it.

43. The following suggestions for possible UNIDO action deserve closer consideration:

(a) Assisting developing countries in building the technical and scientific capacity to develop, absorb and diffuse pollution prevention techniques and cleaner production processes essential to making the transition to ESID. This could be done:

(i) By adapting ESID to special needs of developing countries within their means;

(ii) By demonstrating the financial and economic advantages and environmental benefits of ESID to present and future generations;

(iii) By providing technical support on designing, establishing, operating, evaluating and monitoring pollution prevention techniques and cleaner production processes and technologies;

(iv) By establishing demonstration and training centres at new or existing industrial facilities, and providing support to centres of excellence;

(b) Assisting in the implementation of international environmental conventions and protocols:

(i) By providing technical assistance to developing countries to identify and implement needed actions;

(ii) By helping developing countries to locate expertise and funding for projects that contribute to implementation;

(c) Assisting developing countries in determining the environmental soundness of industrial technologies:

(i) By preparing guidelines on environmentally sound industrial practice for selected sectors;

(ii) By promoting, in selected sectors, technical procedures to evaluate and to test processes, products and services;

(d) Assisting developing countries in integrating environmental considerations into their industrial strategies and policies:

(i) By identifying sectoral and subsectoral priorities for environmentally sound industrial activities;

(ii) By specifying the measures needed to rehabilitate existing industries so that they could operate in a manner that is more "friendly" to the environment, as well as by giving an assessment of the costs of such a transition and the time-frame for achieving it;

(iii) By examining their current policies on such topics as industrial taxes and subsidies and resource-pricing in order to identify and remove factors that encourage inefficient and environmentally damaging activities;

(e) Strengthening its existing database and capacity to coordinate the dissemination of technical and policy information on ESID by cooperating with UNEP on building up and operating the International Cleaner Production Information Clearinghouse and through other means.

THE ROAD TO ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

Working Paper No. I

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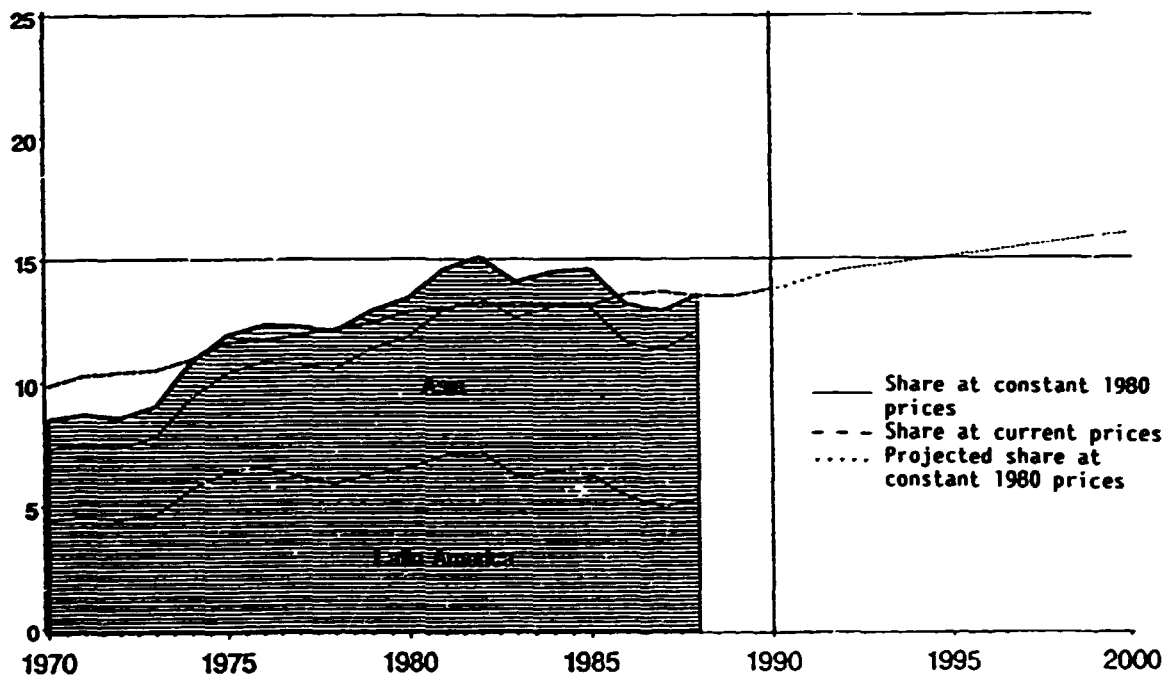
I. PAST TRENDS IN INDUSTRIAL GROWTH AND POLLUTION

1. For the world as a whole, industrial output (taken as manufacturing value added) grew at an annual rate of 3.6 per cent during the last 20 years (see table 1), compared with population, which grew at 1.8 per cent. The manufacturing value added (MVA) of developed market economies grew at an annual rate of 3.1 per cent, while their population grew at 0.7 per cent. In the third world, noteworthy gains occurred in some regions, particularly East Asia and South-East Asia, which experienced annual growth of 9.1 per cent in industrial output compared with annual growth of 2.1 per cent in population.

2. This growth in the industrial output of developing countries did not meet expectations, particularly in the 1980s. Overall, the share of these countries in global industrial output, in current prices, increased only modestly, from 9.3 per cent to 13.8 per cent from 1970 to 1990, with most of that increase occurring from 1970 to 1980 (figure I). Moreover, 10 countries accounted for over 60 per cent of the total MVA of all 116 developing countries and 18 countries, for nearly 80 per cent. 1/

Figure I. Share of developing countries in world (excluding China) manufacturing production*



*The Lima Declaration and Plan of Action on Industrial Development and Co-operation, adopted by the Second General Conference of UNIDO, held at Lima from 12 to 26 March 1975, called for their share to be increased to the maximum possible extent and as far as possible to at least 25 per cent of total world industrial production by the year 2000.

3. Events over the past 20 years are disturbing also in respect of environmental deterioration for all countries. Most startling are the threats to the biosphere, to which industrialization contributes a significant share.

Table 1. Population, GDP, MVA and their growth rates, 1970 to 2010
(Millions of persons and millions of 1980 US dollars)

Region a/	1970			Growth rate 1970-1980			1980		
	Pop.	GDP	MVA	Pop.	GDP	MVA	Pop.	GDP	MVA
World	3 698	7 836	1 881	1.9	3.8	4.1	4 450	11 405	2 844
Developed									
DME	706	5 677	1 413	0.8	3.1	3.2	762	7 764	1 953
CPE Eastern Europe and USSR	331	651	255	0.9	5.1	6.6	361	1 080	494
Other developed	38	191	38	2.0	3.0	3.0	46	257	51
Developing									
North Africa	83	73	7	2.6	6.6	6.2	108	140	12
Tropical Africa	257	95	8	2.9	3.0	3.7	345	128	12
Latin America	285	418	96	2.4	5.8	6.1	362	747	177
Western Asia	99	237	17	3.0	5.8	7.0	133	424	35
Indian subcontinent	753	168	22	2.3	3.2	4.4	943	232	35
East and South-East Asia	262	150	25	2.3	7.7	10.9	329	325	75
CPE Asia	884	176		1.8	5.6		1 062	307	
Developing	2 623	1 317	176	2.2	5.6	6.8	3 282	2 304	345
Developed	1 075	6 520	1 706	0.8	3.3	3.8	1 169	9 101	2 499

Region a/	1980			Growth rate 1980-1990			1990		
	Pop.	GDP	MVA	Pop.	GDP	MVA	Pop.	GDP	MVA
World	4 450	11 405	2 844	1.7	2.9	3.2	5 289	15 178	3 921
Developed									
DME	762	7 764	1 953	0.6	2.7	3.1	805	10 174	2 669
CPE Eastern Europe and USSR	361	1 080	494	0.7	2.4	3.1	388	1 378	675
Other developed	46	257	51	1.9	2.6	1.4	56	332	59

continued

Table 1 (continued)

Region a/	1980 Pop.	1980 GDP	1980 MVA	Growth rate 1980-1990 Pop.	Growth rate 1980-1990 GDP	Growth rate 1980-1990 MVA	1990 Pop.	1990 GDP	1990 MVA
Developing									
North Africa	108	140	12	2.8	2.6	5.3	142	182	21
Tropical Africa	345	128	12	3.0	1.6	2.1	467	150	14
Latin America	362	747	177	2.1	1.3	1.0	448	852	195
Western Asia	133	424	35	3.3	-0.1	5.3	186	421	60
Indian subcontinent	943	232	35	2.2	5.3	7.2	1 179	394	71
East and South-East Asia	329	325	75	1.9	6.0	7.4	399	593	157
CPE Asia	1 062	307		1.4	8.2		1 220	701	
Developing	3 282	2 304	345	2.1	3.6	4.1	4 040	3 293	518
Developed	1 169	9 101	2 499	0.7	2.7	3.1	1 249	11 885	3 402

Region a/	1990 Pop.	1990 GDP	1990 MVA	Growth rate 1990-2000 Pop.	Growth rate 1990-2000 GDP	Growth rate 1990-2000 MVA	2000 Pop.	2000 GDP	2000 MVA
World	5 289	15 178	3 921	1.7	3.4	3.5	6 260	21 387	5 563
Developed									
DME	805	10 174	2 669	0.4	3.0	3.4	838	13 734	3 749
CPE Eastern Europe and USSR	388	1 378	675	0.7	3.5	1.5	416	1 956	784
Other developed	56	332	59	1.6	3.2	4.7	65	457	95
Developing									
North Africa	142	182	21	2.3	3.5	5.6	180	258	36
Tropical Africa	467	150	14	3.3	4.0	5.5	647	223	25
Latin America	448	852	195	1.9	4.2	5.6	542	1 296	341
Western Asia	186	421	60	3.2	4.0	6.0	254	628	109
Indian subcontinent	1 179	394	71	2.0	5.0	6.1	1 439	650	132

continued

Table 1 (continued)

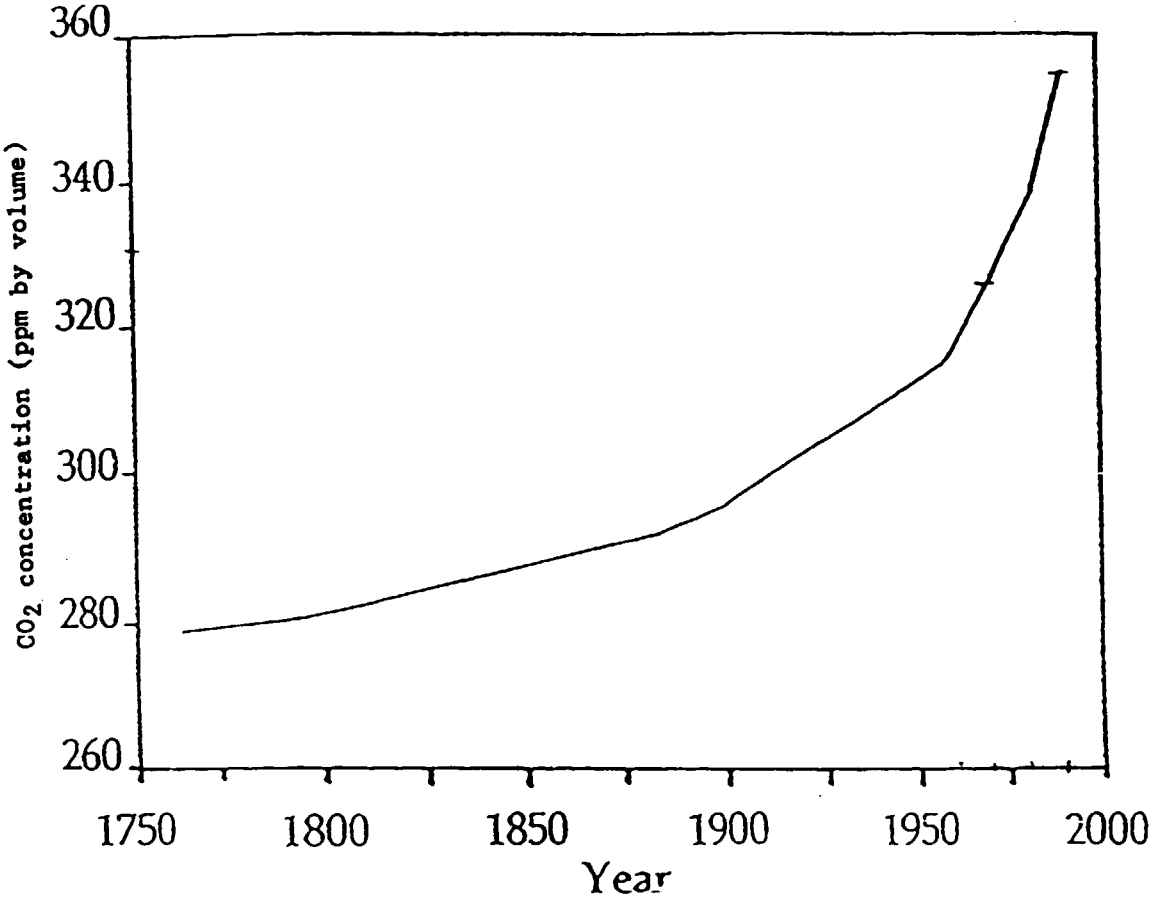
Region a/	1990 Pop.	1990 GDP	1990 MVA	Growth rate 1990-2000 Pop.	Growth rate 1990-2000 GDP	Growth rate 1990-2000 MVA	2000 Pop.	2000 GDP	2000 MVA
East and South-East Asia	399	593	157	2.0	5.5	6.2	487	1 029	292
CPE Asia	1 220	701		1.3	5.0		1 392	1 155	
Developing	4 040	3 293	518	2.0	4.6	5.9	4 941	5 240	935
Developed	1 249	11 885	3 402	0.6	3.1	3.1	1 319	16 147	4 628

Region a/	2000 Pop.	2000 GDP	2000 MVA	Growth rate 2000-2010 Pop.	Growth rate 2000-2010 GDP	Growth rate 2000-2010 MVA	2010 Pop.	2010 GDP	2010 MVA
World	6 260	21 387	5 563	1.5	3.5	3.6	7 238	30 236	7 934
Developed									
DME	838	13 734	3 749	0.3	2.8	3.1	863	18 172	5 112
CPE Eastern Europe and USSR	416	1 956	784	0.5	4.0	2.0	438	2 918	957
Other developed	65	457	95	1.4	3.1	4.5	75	623	149
Developing									
North Africa	180	258	36	2.0	4.6	6.1	219	409	67
Tropical Africa	647	223	25	2.7	5.0	6.8	847	368	49
Latin America	542	1 296	341	1.5	5.0	6.0	630	2 137	622
Western Asia	254	628	109	2.8	4.5	7.3	336	985	225
Indian subcontinent	1 439	650	132	1.8	5.0	6.1	1 723	1 072	242
East and South-East Asia	487	1 029	292	1.8	4.7	5.6	583	1 646	511
CPE Asia	1 392	1 155		0.9	5.0		1 523	1 905	
Developing	4 941	5 240	935	1.7	4.9	6.1	5 862	8 523	1 716
Developed	1 319	16 147	4 628	0.4	3.0	3.0	1 376	21 713	6 218

a/ DME denotes developed market economies and CPE denotes centrally planned economies.

4. One such threat is the concentration in the atmosphere of carbon dioxide (CO_2), a primary contributor to the greenhouse effect, which has increased by 10 per cent over the last 20 years (figure II).* As a result of increasing emissions of CO_2 and other greenhouse gases, the average global temperature will probably increase from 15.2° C in the 1980s to between 16.7 and 19.7° C by 2030. 2/ Approximately two thirds of the CO_2 released into the atmosphere can be attributed to human activities, particularly fossil fuel combustion; and about one third of fossil fuel combustion is either directly or indirectly connected to industrial activity.

Figure II. Global CO_2 concentrations



Source: G. Heaton, R. Repetto, and R. Sobin, eds., Transforming Technology: An Agenda for Environmentally Sustainable Growth in the 21st Century (World Resources Institute, April 1991).

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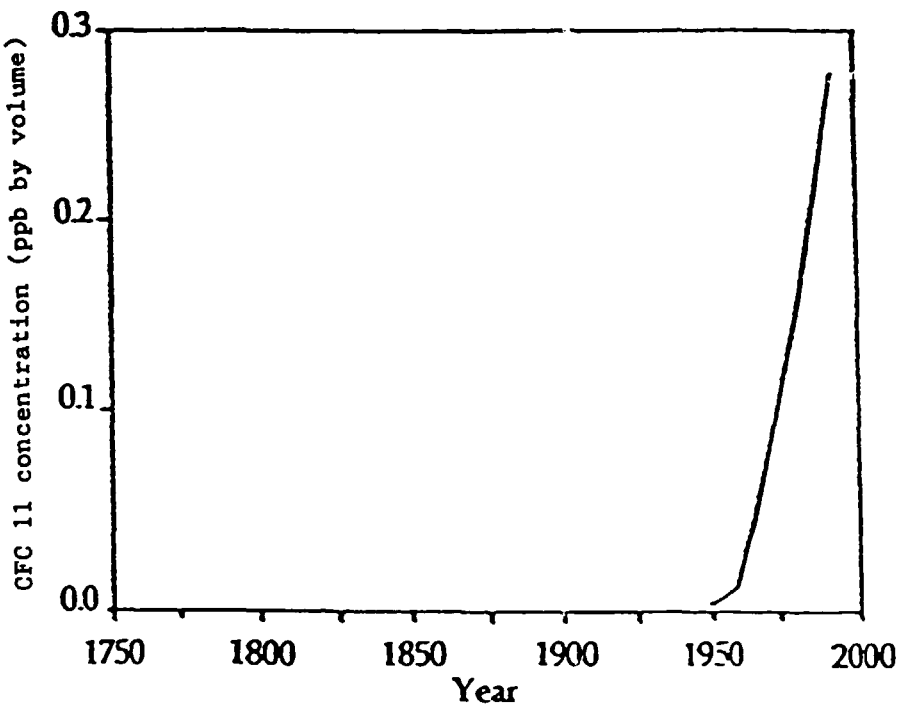
*Other anthropogenic greenhouse gases are nitrous oxide from the chemical industry and the use of synthetic nitrogenous fertilizers; methane from rice cultivation, grazing animals, natural gas transmission leaks and coal mining; and synthetic chlorofluorocarbons (CFCs).

5. A second area of concern is the concentration in the atmosphere of chlorofluorcarbons (CFCs), which have increased dramatically (figure III). CFCs are used in refrigerators and air-conditioners, in the blowing of plastic foam and as a solvent. They are the main cause of the "ozone hole", the name given to the decline in stratospheric ozone, which protects the surface of the earth from damaging ultraviolet radiation. Increased ultraviolet radiation promotes skin cancers and cataracts and depresses human immune systems; it also reduces crop yields, depletes marine fisheries, accelerates the deterioration of materials and increases smog. The higher concentration of CFCs also contributes to global warming.

Figure III. Concentration of trichlorofluoromethane (CFC 11)

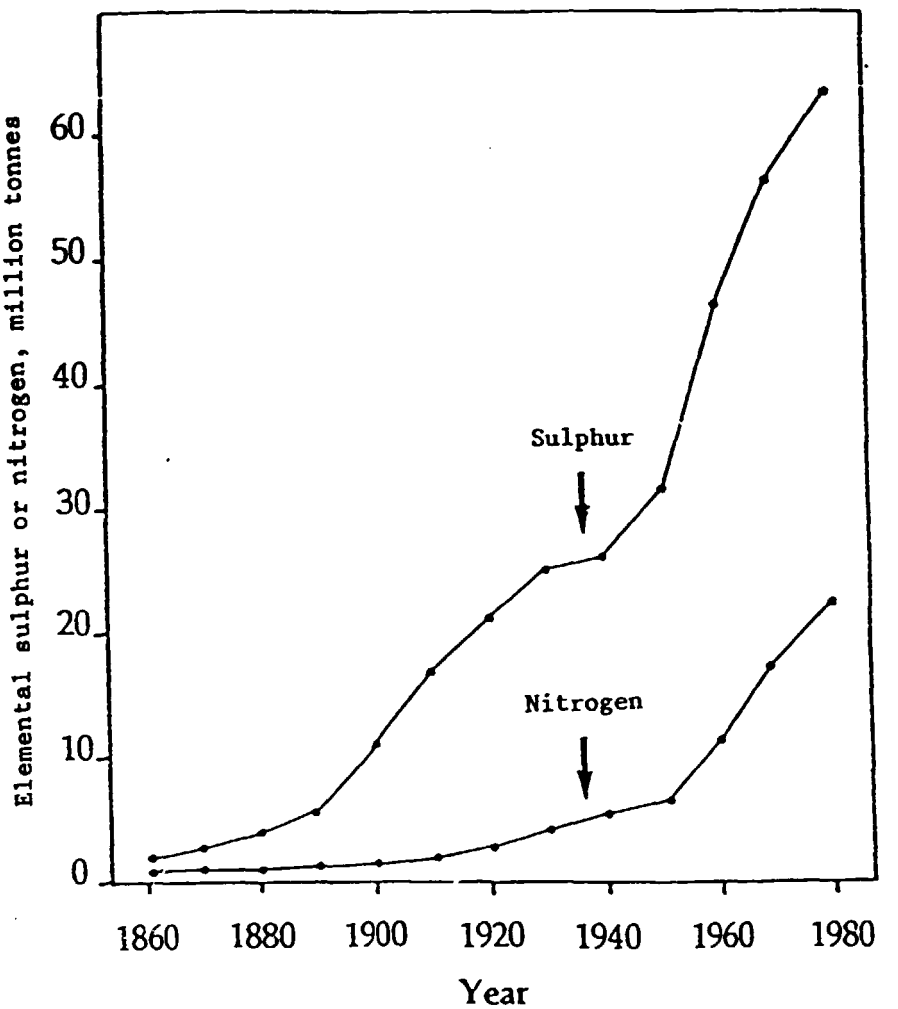


Source: Intergovernmental Panel on Climate Change, Climate Change: the IPCC Scientific Assessment (World Meteorological Organization and United Nations Environment Programme, 1990).

6. A third area of concern is the increasing emissions of sulphur dioxide (SO_2) and nitrogen oxides (NO_x), which increased by 40 per cent and 100 per cent, respectively, from 1960 to 1980 (figure IV). These pollutants are the main reasons for the growing acidity of the natural environment, especially freshwater lakes, rivers, forests and soils, and they contribute to the deterioration of the man-made environment, especially stone buildings and metallic infrastructure. These pollutants are produced mainly by the combustion of fossil fuels, primarily from power plants. It should be noted that the effects of acidification may have been masked until comparatively recently by the

buffering effects of alkaline fly ash. However, the increasing use of smoke-control technology, especially electrostatic precipitators, may tend to accelerate the acid build-up by decreasing the buffering effect.

Figure IV. Global emissions of nitrogen and sulphur oxides from fossil fuel consumption



Source: J. Dignon and S. Hameed, "Global emissions of nitrogen and sulfur oxides from 1860 to 1980", Journal of the Air Pollution Control Association, vol. 39, No. 2 (1989), p. 183.

7. A fourth area of concern is wastes, primarily toxic chemicals and heavy metals, which are dispersed locally and build up in soils or sediments. The most polluted areas are probably United States and European river basins, such as those of the Thames, the Rhine-Schelde, the Elbe, the Danube, the Vistula, the Po, the Hudson-Raritan, the Delaware, the Ohio and the lower Mississippi, which became industrialized in the last 100-150 years. There are no global data on such accumulations. There are, however, global estimates of annual

atmospheric emissions of heavy metals (table 2). Anthropogenic emissions of lead, cadmium, vanadium, and zinc exceed emissions from natural sources by factors of 28, 6, 3 and 3, respectively. Industrial contributions of arsenic, copper, mercury, nickel and antimony are as much as twice those from natural sources. In addition, atmospheric fallout, domestic and industrial wastewater discharges and urban runoff have caused significant inputs of trace metals into aquatic ecosystems and soils, threatening the biosphere as a whole, including regional seas and the oceans.

8. Industry is a major contributor to these environmental concerns.* It includes activities such as manufacturing, mining, utilities and construction. Of these sectors, manufacturing alone accounts for, on average, one third of total final energy consumption. More specifically, five manufacturing sub-sectors are known to be the most energy- and materials-intensive as well as the most pollution-intensive: iron and steel; nonferrous metals; nonmetallic minerals; chemicals; and pulp and paper. 3/

9. For a long time, industry in developed countries has been the major contributor to these problems of the biosphere, but the situation is changing with the rapid industrialization of developing countries. Whereas the developed countries have to some degree delinked energy and industrial output, developing countries have done just the reverse. In fact, the delinking phenomenon is partly due to structural shifts, namely the gradual relocation of resource-based (and energy-intensive) industries, such as steel, aluminium and petrochemicals, from the industrialized countries to the developing countries. Industrial final energy consumption in developed countries declined at an annual rate of 0.65 per cent in 1973-1985 and 1.93 per cent in 1980-1985, while industrial output increased at an annual rate of 1.50 per cent in 1973-1980 and 3.24 per cent in 1980-1985. In sharp contrast, industrial energy consumption in the developing countries as a whole, excluding China, grew at an annual rate of 6.32 per cent in 1973-1980 and 4.83 per cent in 1980-1983, while industrial output grew by 3.82 per cent and 0.03 per cent in the same periods. Similarly, four out of the five materials-, energy- and pollution-intensive manufacturing sectors listed above grew faster in developing countries than in developed countries during 1970-1988 and grew twice as fast in developing countries as in developed countries during 1980-1985. 4/

II. DEFINITION OF ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

10. There has been a good deal of debate on the meaning of the term "sustainable development". The World Commission on Environment and Development of the United Nations offered several definitions of sustainable development. 5/ The one that is most often repeated is that sustainable development "meets

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*For the purpose of collecting data, industry is defined to include all operations falling into categories 2, 3 and 4 of the International Standard Industrial Classification (ISIC). Thus it includes mining, petroleum and gas extraction, electricity, waterworks and related activities. However, manufacturing (ISIC 3) is the largest and most important industrial sector, and it is in this sector that the work of UNIDO concentrates. It is also to this sector that the term "industry" mainly refers in all Working Papers.

Table 2. Worldwide atmospheric emissions of trace metals
(Thousand tonnes per year)

Element	Energy production	Smelting, refining and mining	Manufacturing processes	Commercial uses, waste incineration and transportation	Total anthropogenic contributions	Total contributions by natural activities
Antimony	1.3	1.5	-	0.7	3.5	2.6
Arsenic	2.2	12.4	2.0	2.3	19.0	12.0
Cadmium	0.8	5.4	0.6	0.8	7.6	1.4
Chromium	12.7	-	17.0	0.8	31.0	43.0
Copper	8.0	23.6	2.0	1.6	35.0	6.1
Lead	12.7	49.1	15.7	254.9	332.0	28.0
Manganese	12.1	3.2	14.7	8.3	38.0	12.0
Mercury	2.3	0.1	-	1.2	3.6	317.0
Nickel	42.0	4.8	4.5	0.4	52.0	2.5
Selenium	3.9	2.3	-	0.1	6.3	3.0
Thallium	1.1	-	4.0	-	5.1	29.0
Tin	3.3	1.1	-	0.8	5.1	10.0
Vanadium	84.0	0.1	0.7	1.2	86.0	28.0
Zinc	16.8	72.5	33.4	9.2	132.0	45.0

Source: J. O. Nriagu, "Global metal pollution: poisoning the biosphere?", Environment, vol. 32, No. 7 (1990), pp. 7-32.

the needs of the present without compromising the ability of future generations to meet their own needs".

11. Any definition ought to address three issues:

(a) The explicit contribution of ecological processes to living standards;

(b) The access by future generations to as effective a resource base as that enjoyed by the present generation, if living standards are not to decline over time;

(c) The resource base, which must include a mix of man-made and natural capital.

12. The last issue, the appropriate mix of man-made and natural capital that needs to be preserved for future generations, is at the centre of the sustainability debate. The components of this capital are four: man-made capital; non-renewable resources; renewable resources; and common property resources (air, water and soil). Often thought of as cost-free, common property resources, in particular those of the biosphere, are at greatest risk from industrial activities, because both the production processes and the products themselves generate residuals that enter the water, air and soil.

13. There is considerable disagreement about the extent to which industrialization can sacrifice environmental assets - particularly common property resources - and still result in sustainable development.* There are those, primarily traditional economists, who see sustainable development only in terms of growing wealth, which allows for substitution between man-made and natural capital (the weak definition). Their concern is that the overall aggregate of man-made and natural capital should not decline from one generation to the next. On the other hand, there are those who see sustainable development under the constraint of non-declining natural wealth, which does not allow for substitution between man-made and natural capital (the strong definition). Their concern is that a similar natural endowment should be available from one generation to the next. Those advocating the strong definition challenge the substitutability argument, as applied to natural environmental capital. They point out that there is no plausible way to recreate the ozone layer of the stratosphere or to remove greenhouse gases from the atmosphere. Nor is there any plausible technological solution to the problems of increasing environmental acidification and/or toxification. Finally, there is no way to replace genetic information that is lost when species disappear forever.

14. On the basis of the growing scientific evidence in support of the strong definition of sustainable development, UNIDO proposes a definition of ecologically sustainable industrial development (ESID) that tends to preserve natural capital and allows a low degree of substitutability by man-made capital. ESID is defined as those patterns of industrialization that enhance economic and social benefits for present and future generations without impairing basic ecological processes.

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*For an elaboration of this argument, see D. Pearce, N. Markandya and E. Barbier, Blueprint for a Green Economy (London, Earthscan Publications, 1990), chap. 2.

15. This definition of sustainability does not admit major man-made changes to climate, human interference with the carbon cycle, anthropogenically induced deforestation of the tropics, accumulation of toxic heavy metals and non-biodegradable halogenated organics in soils and sediments or sharp reductions in biodiversity. It follows, therefore, that any significant degradation of ecological processes by industrialization, as well as by other human activities, is ipso facto unsustainable over long periods.

III. CRITERIA FOR ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

16. UNIDO proposes three criteria that a particular pattern of industrialization must satisfy if it is to be deemed ecologically sustainable:

(a) It must protect the biosphere;

(b) It must make the most efficient use of man-made and natural capital;

(c) It must promote equity.

A. Protection of the biosphere

1. The concept of eco-capacity

17. The concept of eco-capacity has two aspects. On the one hand, it refers to the capacity of an ecosystem to be resilient, that is to maintain its patterns of behaviour in the face of external disturbance. On the other, it refers to the capacity of the system to remain stable, that is to maintain its equilibrium in response to normal fluctuations in the environment. It is the first aspect of the concept that is of interest here.

18. Protecting the biosphere from industrially related activities is a fundamental criterion for sustainable development. It is also a very difficult one to measure because it is multidimensional. It includes stabilizing the biosphere in the face of the threats from greenhouse gases and ozone-depleting substances, maintaining the carrying capacity of natural resource systems (forest, fisheries and agricultural land) and protecting the absorptive (assimilative) capacity of air, water, and soil from emissions and waste discharges.

19. Complicating the analysis is the continuing expansion of our scientific knowledge and the uncertainty surrounding that knowledge at a time when decisions must be made. One has only to look at the environmental concerns cited at the beginning of this paper. For example, CFCs came into commercial use in the 1930s. 6/ They were heralded as a significant environmental improvement because the common refrigerants at the time - ammonia, methyl chloride and SO_2 - were not suitable as home refrigerants owing to their noxious and toxic properties. In the 1940s, CFCs were used as aerosols for insecticides such as dichlorodiphenyltrichloroethane (DDT) and later they were used widely as solvents by the microelectronics industry. Only in the early 1970s did scientific studies, which were confirmed by direct observations in the 1980s, demonstrate that these long-lived substances damaged the stratospheric ozone layer.

20. Another example of expanding knowledge turns up in connection with the regulation of SO_2 in the United States. 7/ In 1971, the United States

Environmental Protection Agency set the ambient standards for this pollutant on the basis of considerable scientific data that had been assembled in the 1960s; these standards have since been adopted by many nations. At the time, the Environmental Protection Agency considered the standards adequate to protect not only human health but also natural ecosystems. Now, in the 1990s, it is calling for a total loading standard, that is, a further 50 per cent reduction in SO_2 emissions, over and above that required by the annual ambient standard, because of concern about the effects of acid deposition on natural ecosystems.

2. Strategies for protection

21. There are two main strategies for protecting the biosphere. The first, which is less restrictive, is to keep annual emissions and wastes from industrial activity within the limits of ambient environmental standards. Ambient standards set acceptable concentrations of the various pollutants in the environment. They are based on the effects of pollutants on human health and on flora and fauna and often vary, particularly for water quality, where they depend on the use of the receiving body of water (e.g. more stringent standards are required for rivers that are sources of drinking water). Standards are difficult to establish because of inadequate scientific information, particularly about the effects of minuscule concentrations of toxic chemicals. In addition, they are difficult to implement because complex modelling is required to relate industrial discharges to overall ambient concentrations. At the national and international levels, ambient standards exist for common pollutants such as particulate matter and SO_2 and for several toxic pollutants, such as heavy metals and selected organic compounds.

22. Environmental managers have adopted an alternative in response to the shortcomings of ambient standards. This alternative, discharge standards, emerged in the 1970s in response to the difficulties of relating emissions to ambient concentrations. Discharge standards are expressed in terms of the concentration of a pollutant in the effluent stream or in terms of the allowable quantity of pollutant discharge per unit of raw material or product output. 8/ These standards, which have evolved over the past 20 years, are usually determined on the basis of available technology and economic considerations. While they eliminate the problem of relating emissions to ambient concentrations, they can reduce pollutant discharges to a greater or lesser extent than is needed for environmental protection.

23. The second major strategy for protecting the biosphere, now emerging in light of global and regional environment problems, is to stabilize and eventually reduce total loadings of pollutants of global and regional concern. This more restrictive strategy recognizes the limitations of science in determining acceptable concentrations for pollutants that have irreversible effects.* The pollutants at issue are those associated with global and regional air pollution problems, primarily global warming, ozone depletion and acid deposition, and those causing the deterioration of aquatic ecosystems, primarily toxic heavy

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*For example, the United States invested more than $500 million over a 10-year period in research to determine the amount of SO_2 reduction that would be necessary to protect aquatic and terrestrial ecosystems. In the end, the report could not refute the political decision to reduce SO_2 emissions by 50 per cent nor could it suggest another target.

metals and chlorinated hydrocarbons. The aim of the total loading standards is to reduce pollutant loadings to the environment to a level below that required by ambient standards. A clear expression of support for total loading standards at the regional level is the Bergen Ministerial Declaration on Sustainable Development in the ECE Region, which calls for significant reductions in CO_2, SO_2 and NO_x emissions and for the replacement of hazardous chemicals and their safe disposal. 9/ At the national level, one endorsement of the total loading standard for the pollutants of concern is the national environmental policy adopted by the Government of the Netherlands. 10/

24. The meeting of total loading standards is a more costly and long-term strategy but also a more important one because it would impose more stringent discharge limitations than ambient standards. Total loading standards call for very low levels of pollutant discharge so as to protect the ozone layer, the climate-stabilizing system and the key cycles - carbon/oxygen, nitrogen, phosphorus and sulphur. It is essential to recognize that continuous reduction of emissions per unit of output is not sufficient to achieve ESID. Emissions must be reduced in absolute terms, for the industrial system as a whole. In the long run this implies (a) the massive substitution of renewable (e.g. solar or biomass) energy for fossil fuels, especially coal, and (b) the closing of the materials and product cycles through optimal processes and optimal products, as discussed in Working Paper III, which discusses the role of industry in achieving ESID.

B. Efficiency

25. Even if the overriding concern of sustainable development is the preservation of the natural environment, this should be done in an efficient manner. Thus, if there are alternatives for maintaining eco-capacity, the idea would obviously be to choose those that minimize input (of energy, for example) per output produced or that maximize output per input needed. This follows from the fact that the notion of development is central to ESID, and development, in turn, implies rising living standards, at least in the broad sense. As attested to by economic history, economic development by means of industrialization (the transformation of raw materials into products) has long been the path to higher standards of living. Hence industrialization policies have to be consistent with achieving the most efficient conversion of raw materials into outputs.

C. Equity

26. There is one further criterion that needs to be applied, namely the promotion of equity. The issue of equity takes a number of forms. The first is the equitable distribution of environmental burdens as well as outputs. The solution of this issue may have important repercussions for the preservation of the environment. If the costs of meeting environmental standards are considered to be too high, sizeable segments of the population, many of them already poor, will suffer the consequences of this decision, i.e. a degraded environment, and this will make them poorer. The cycle spirals downwards because poverty *per se* breeds some of the worst forms of environmental degradation, i.e. deforestation, over-exploitation of marine resources, unsanitary living conditions etc., as discussed in paragraph 29.

27. On a global scale, the issue of equity arises in another way. One argument is that the industrialized countries, which have benefited the most

from the exploitation of natural resources and the waste assimilative capacity of the biosphere, now have a moral obligation to permit the developing countries to follow similar growth patterns. This argument implies that industrialized countries should pay the excess costs incurred by the developing countries to protect the environment. However, this moral argument is not necessarily accepted by those who would have to pay the excess costs. A more effective argument might well be based on interlocking mutual security and economic interests. This was the argument that justified the Marshall Plan after the Second World War. At present, a number of West European countries have found it cost-effective, i.e. in their own interests, to assist Poland and the other East European countries to reduce air pollution. Such arguments can be applied on a global, as well as a regional, scale.

28. A third aspect of the equity issue is intergenerational equity. The present generation is clearly paying for the degradation of natural resources, such as deforestation, overgrazing and erosion, caused by earlier generations. Future generations will, however, have to pay not only the costs of current environmental degradation of the same kind (only accelerated) but also the costs of accumulations of atmospheric gases and toxic heavy metals and the loss of tropical rain forests and biological diversity. One implication of this understanding is that the needs of future generations should be taken into account even if this places an additional strain on political institutions, which are normally geared to achieving short-term targets and not to satisfying future generations.*

29. Two further aspects of the equity issue are especially relevant to industry. First, all countries need to participate in the shift to cleaner production processes, which are at the core of ESID. Industrialization in developing countries has the potential to go forward with much smaller energy and raw material inputs than developed countries needed at similar stages of industrialization. (Cleaner production processes could maximize this potential, as discussed in section V.) Secondly, unless employment opportunities are created for marginalized populations, they will continue to resort to environmentally unsound farming, grazing and fishing, giving rise to environmental disasters such as desertification, deforestation and the depletion of topsoils. One study estimates that deforestation in developing countries accounts for 23 per cent of global CO_2 emissions and says that it shows little sign of diminishing. 11/

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*Indeed, there is a deep underlying ethical divide on the issue of intergenerational equity. On one side are those who argue that discounting, which is how society currently evaluates the future costs and benefits of present actions, is ethically justified because future generations will be the gainers. While current generations may use up the earth's natural resources, they endow their descendants with greater scientific knowledge and more powerful technologies, not to mention invested capital, than their ancestors left them. On the other side are those who see man as part of nature with no special rights over other species. Somewhere in between is Thomas Jefferson's view that the environment is a common property of all generations, held by the living in usufruct for the unborn. These two positions correspond to very different choices of a discount rate: very high in the first case and very low (or zero) in the second.

30. It is difficult to lay out a path that would consistently satisfy all three criteria.* There will have to be trade-offs between them, and these will be based on value judgements. For instance, a certain investment strategy might create more jobs, but it would not necessarily lead to the most economically efficient production, which is often based on capital-intensive, clean technologies. Similarly, there might be trade-offs between economic efficiency and the protection of eco-capacity. Pollution reduction measures, particularly those that reduce conventional pollutants, might not be the most economically efficient investments because they would divert capital from more productive investments. Trade-offs between efficiency and eco-capacity for pollutants that threaten basic life support systems are a lesser problem. At any rate, the criteria will have to be weighted, and this can only be done through the political process. Whatever the outcome of such a process, it is essential that the importance of the criteria is understood by the affected public.

IV. PROGRESS TOWARDS ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

31. The question that now arises is, How well is industry doing in meeting the three criteria for ESID? It is a difficult question to answer because there is a lack of industry-specific data, but a reasonable assessment can be made using existing data and approximate measures.

32. In accordance with the preventive strategies discussed in section III, UNIDO suggests two ways to measure progress towards protecting the biosphere. One is compliance with ambient environmental standards, the other is compliance with total loading standards.

A. Ambient standards

33. Industry is only one of many contributors to the degradation of the environment. Agriculture, mining, energy, transport, services and households also contribute in varying degrees. Not enough data are available at the global level to assess the relative contribution of these various sources to ambient environmental deterioration. There is information, however, on the relative contribution of pollutant loadings into the environment.

34. Environmental deterioration associated with industrial development occurs at both the input and the output sides of production activities. Industrial production requires the input of a wide variety of natural resources, such as water, energy, minerals, forest products and other raw materials whose rapid depletion may cause environmental damage and ecological disruption. On the output side, the manufacturing process generates myriad wastes, including

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*There are a number of elegant mathematical models of the economic growth process that suggest how in theory the three criteria for ESID ought to be integrated to achieve optimal growth. Such models have been surveyed by R. Solow, "On the intergenerational allocation of natural resources", Scandinavian Journal of Economics, vol. 88 (1986), pp. 141-149. The arguments have recently been taken further by K.-G. Maler, "Sustainable development", World Bank, Washington, D.C., 1989 and by E. Barbier and A. Markandya, "The conditions for achieving environmentally sustainable development", European Economic Review, vol. 34, No. 2/3 (1990), pp. 659-669.

hazardous wastes, toxic chemicals and thermal wastes, that pollute the soil, the air and surface water and groundwater. On the output side, too, many manufactured end-products, such as pesticides, detergents, paints, plastics and combustion engines, add to the pollution.

35. In Industry and Development: Global Report 1990/91, UNIDO assessed the global degradation of the environment from both the input and output sides of production activities. 3/ On the input side, it looked at the consumption of water, energy and mineral resources:

(a) Water. Industry uses much less water than agriculture, but it pollutes the water more. Although more than 80 per cent of the water used for cooling and cleaning is returned, the returned water is often contaminated by industrial effluents and thermal pollution;

(b) Energy. In the countries of the Organisation for Economic Co-operation and Development (OECD), industry used more energy than any other sector in 1970-1987. Its share ranged from 40 per cent in 1970 to 33 per cent in 1987. The industrial share of energy consumption in developing countries varied from country to country, ranging from 63 per cent in China to 20 per cent in West Africa;

(c) Mineral resources. There seems to be no cause for concern about the exhaustion of mineral resources within the foreseeable future, although political disruptions can always lead to temporary shortages. More important in connection with mineral resources are the environmental problems posed by their production and industrial use;

36. On the output side, the Global Report analysed air pollution, water pollution, solid wastes, hazardous wastes and toxic chemicals:

(a) Air pollution. The manufacturing sector is not the sector that generates the most air pollutants. Each major air pollutant has a different major source: electricity generation accounts for the bulk of anthropogenic emissions of SO_2; transport activities, for NO_x and CO; and motor vehicles, for hydrocarbons and lead. Industry, however, is a major source of particulate emissions in many countries;

(b) Water pollution. Industry is responsible for a fairly large share of waste-water discharges containing traditional pollutants. Estimation of the share is complicated by the fact that in many countries industry discharges its waste into municipal waste-water systems. Fragmentary data indicate that the share of industry in total waste-water discharges is roughly 20 per cent;

(c) Solid wastes. An inter-country comparison of solid waste generation is difficult owing to the different definitions for categories of wastes. A few country estimates are as follows: industry's share of solid waste generation accounts for 17 per cent of the total in the United States, 9 per cent in France and 60 per cent in Japan;

(d) Hazardous wastes. National data on hazardous wastes are scarce and incomplete. Even when available, they are not comparable because of the widely varying definitions and classification schemes for hazardous wastes adopted by different countries. Bearing these limitations in mind, the fragmentary data show that, with some minor exceptions, the largest portion of hazardous wastes

is generated by industrial production. For instance, in the United States over 85 per cent of the hazardous waste is accounted for by the manufacturing sector; in Thailand, this share is over 95 per cent;

(e) Toxic chemicals. It is difficult to estimate the quantity of toxic chemical wastes produced in different countries each year, partly because the term "toxic" is defined differently in different countries. Some recent data from the United States seem, however, to permit the identification and quantification of the types and sources of toxic chemical wastes. The chemical industry accounted for 54 per cent of the total releases, followed by the paper products and primary metals subsectors.

37. In summary, while the available data allow a reasonable assessment for industrialized countries, the relative contribution of industry to overall environmental degradation in developing countries is little known. For OECD countries, the industrial sector in 1987 accounted for 15 per cent of the total water use, 25 per cent of NO_x, 35 per cent of final energy use, over 40 per cent of SO_2 emissions, 50 per cent of greenhouse gas emissions, 60 per cent of the water pollution (biochemical oxygen demand), 75 per cent of non-hazardous inert waste and 90 per cent of toxic substances discharge to water. For developing countries, as well as the countries of Eastern Europe, the data on the relative contribution of industry to environmental deterioration are very fragmentary, as can be seen in a recent report from the Economic and Social Commission for Asia and the Pacific (ESCAP). 12/ There is obviously significant variation, given the different levels of industrialization, between developed and developing countries as well as among developing countries. For example, industry's share of total final energy use, which use constitutes a major threat to the biosphere, was 34 per cent in Africa, 40 per cent in Latin America and around 55 per cent in Eastern Europe. 13/

B. Total loadings

38. Meeting current ambient standards is insufficient to prevent global and regional environmental problems. These ambient standards were formulated to protect local populations and natural resources, and they focus on concentrations, or flows, of pollutants. Total loading standards for some pollutants reflect the fact that the cumulative stocks of these pollutants in the environment, as well as the flows into it, are significant and must be reduced. Except in the case of CFCs, the extent to which they must be reduced is an open question.

39. Global emissions of CO_2 from energy use, expressed on a total carbon basis, increased from 4.0 billion tonnes in 1970 to approximately 5.2 billion tonnes in 1985 (table 3). They are projected to reach 10.2 billion tonnes (the mid-point estimate) in the year 2025. 14/ Industry's share of these emissions is estimated to have been 2.0 billion tonnes in 1985, assuming that industry uses slightly more than one third of the world's energy. In 1985, the industrialized countries emitted about 50 per cent of this total, the Union of Soviet Socialist Republics (USSR) and the countries of Eastern Europe about 25 per cent and the developing countries about 25 per cent. In 2025, the distribution is projected to be 35 per cent, 25 per cent and 40 per cent owing to more rapid industrialization in developing countries and the positive linkage between energy consumption and industrial output. Currently, developing countries are experiencing the most rapid increase in CO_2, with average annual growth of 3.7 per cent compared to 1.2 per cent and 2.6 per cent for OECD countries and the USSR and Eastern European, respectively.

40. Global emissions of CFCs increased from 0.8 billion tonnes in 1970 to 1.5 billion tonnes in 1985 and are estimated to increase to 3.9 billion tonnes by 2025 (table 3). In 1985, the industrialized countries emitted about 70 per cent of the world's total, the USSR and the countries of Eastern European about 15 per cent and developing countries (including China) about 15 per cent. In 2025, the industrialized countries are projected to emit about 40 per cent of the world's total, the USSR and countries of Eastern Europe about 15 per cent and developing countries about 45 per cent.

41. Global emissions of SO_2 increased from 63 million tonnes in 1970 to 80.5 million tonnes in 1985 and are projected to increase to 235 million tonnes by 2020 (table 4). These emissions are primarily (85 per cent) attributable to fossil fuel combustion (coal and oil) and secondarily to petroleum refining, the smelting of sulphur-containing ores (copper, lead and zinc) and sulphuric acid production. Assuming that industry uses one third of the world's energy, it was either directly or indirectly (by purchases of electricity) responsible in 1985 for 30 million tonnes of SO_2 emitted into the atmosphere. In 1985, industrialized countries emitted about 40 per cent of the total emissions, the USSR and countries of Eastern Europe for slightly more than 30 per cent and the developing countries for slightly less than 30 per cent. In 2020, the industrialized countries are projected to emit about 15 per cent of the world's total, the USSR and the countries of Eastern Europe about 15 per cent and developing countries about 70 per cent. Most of the increase in emissions by 2020 will be attributable to the increased use of coal in China.

42. Data on the accumulation of trace metals in soils and sediments over the past decades are limited, especially in developing countries.* In the past, developed countries were the main culprits in the discharge of trace metals, but the trend is reversing: "... the combination of natural resource endowments, the constraints imposed by population growth and economic development, and the lack of government regulations can only lead to an increase in the rates of toxic metal discharge in developing countries". 15/

43. Three activities are usually of greatest concern: the mining, smelting and refining of metals; the burning of fossil fuels for energy production; and the manufacturing processes, especially the production of metallic commercial products. A brief look at table 2 confirms that these activities are the main contributors of trace metals into the atmosphere. Manufacturing processes alone, ignoring energy use, are significant contributors of chromium, manganese, nickel, thallium and zinc.

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*The annual production of metals, both from virgin ores and from secondary sources, is known with reasonable accuracy. The annual consumption of non-ferrous metals has been roughly constant or even declining in the United States for the last 20 years. The fraction obtained each year from secondary sources has also remained roughly constant except in the case of lead, where the fraction derived from secondary sources has risen sharply owing to the ban on lead in gasoline. What these data mean is that between half and seven eighths of the annual consumption of each of the heavy non-ferrous metals becomes dispersed and dissipated beyond economic recoverability. The situation in developing countries may be slightly better owing to greater incentives to conserve, but the range of uses is much the same, and for most dissipative uses, from paint to pesticides, recovery is simply not feasible.

Table 3. Emissions of CO_2 and CFCs in 1985 and 2020

Category	Country or region	CO_2 1985 10^6 tonnes/yr as C	%	CO_2 2020 10^6 tonnes/yr as C	%	CFCs 1985 10^6 kg/yr	%	CFCs 2025 10^6 kg/yr	%
Industrialized countries	United States	1 398	50	1 699-2 110	35	441	70	548	40
	OECD Europe/ Canada	795		1 096-1 397		417		765	
	OECD Pacific	302		411-603		199		306	
Centrally planned economies	Eastern Europe/USSR	1 398	25	1 754-2 822	25	232	15	567	15
Developing countries	Centrally planned Asia	521	25	1 014-2 000	40	29	15	212	45
	Middle East	110		493-712		13		90	
	Africa	192		192-795		65		458	
	Latin America	192		438-904		46		291	
	South-East Asia	302		493-1 370		88		618	
Total		5 210	100	7 590-12 713	100	1 530	100	3 855	100

Sources: United Nations Environment Programme, Environmental Data Report, second ed., 1989/90, prepared by GEMS Monitoring and Assessment Research Centre (Oxford, Blackwell, 1989). U.S./Japan Expert Group (1990); Task A Report (1990).

Table 4. Emissions of SO_2 in 1970, 1985 and 2020

Region	1970		1985		2020	
	Emissions (million tonnes/yr)	Share of world total (%)	Emissions (million tonnes/yr)	Share of world total (%)	Emissions (million tonnes/yr)	Share of world total (%)
Industrialized countries	23.0	37	31.0	40	35.0	15
Centrally planned economies	26.0	41	26.0	30	36.0	15
Developing countries	14.0	22	23.5	30	164.0	70
Total	63.0	100	80.5	100	235.0	100

Sources: J. N. Galloway, "Atmospheric acidification: projection for the future", Ambio, vol. 18, No. 3 (1989), pp. 161-166; Global Environment Monitoring System (GEMS); UNEP, Environmental Data Report, second ed., 1989/90 (Oxford, Blackwell, 1989).

V. THE ROAD TO ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

A. The opportunity

44. Predicting the future is difficult, but a plausible scenario for achieving ESID is clear. A recent report from the World Resources Institute stated as follows: "human impact on the natural environment depends fundamentally on an interaction among population, economic growth and technology. A simple identity encapsulates the relationship:

$$\text{Pollution} = \frac{\text{Pollution}}{\text{GDP}} \times \frac{\text{GDP}}{\text{Population}} \times \text{Population}$$

Here, pollution, understood as environmental degradation, emerges as the product of population, income levels (the GDP per capita term) and the pollution intensity of production (the pollution/GDP term)". 16/

45. Clearly, the one variable that can be most easily affected in the short run in this relationship is pollution intensity.* Over the next 20 years (the time frame for this analysis), world population is predicted to increase from 5.3 billion to 7.2 billion (table 1). Similarly, per capita GDP is predicted to increase from $2,900 to $4,100 and per capita MVA from $960 to $1,400. The only choice for avoiding environmental disruption is to reduce pollution intensity by, in the short term, cleaner production and, in the long term, closing the materials and product cycles and shifting to renewable energy resources.

46. The interaction of the three variables is much more complex than indicated by the simple identity above. For example, as per capita GDP increases, the resources needed for reducing pollution intensity increase and the growth of population declines. Similarly, as per capita income increases, the public demand for reducing pollution intensity increases.

B. Cleaner production

47. The concept of cleaner production is evolving from earlier concepts of clean technology and low and non-waste technology. The old concept of clean technology was seen in 1979 by the Commission of the European Communities as having three distinct but complementary purposes: (a) less pollution discharged into the natural environment (water, air and soil); (b) less waste (low waste and non-waste technology); and (c) less demand on natural resources (water, energy and raw materials).

48. Although there is no agreed definition for cleaner production, just as there is no agreed definition for sustainable development, there is some consensus emerging, as evidenced at the United Nations Environment

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*A similar recommendation is contained in Economic Commission for Latin America and the Caribbean, Sustainable Development: Changing Production Patterns, Social Equity and the Environment (LC/G.1648(CON.80/2)), pp. 101-103.

Programme (UNEP) Seminar on the Promotion of Cleaner Production.* The advisory group for the Seminar suggested that cleaner production should be defined as "... a more global approach to environmental protection which would address all phases of the production process or product life cycles, with the objective of prevention and minimization of short- and long-term risks to humans and the environment. Such an approach includes 'cradle-to-grave' minimization of wastes and emissions to air, water and soil, as well as minimization of energy consumption and the use of raw materials". 17/

49. The term cleaner production is technically and operationally very difficult to define, particularly in relation to the "cleanliness" of products.** For the purposes of this paper, cleaner production is best thought of as two things at once: a new environmental quality goal for industry and, at the same time, a new approach for achieving that goal.

50. The new environmental quality goal would require industry to move beyond the current norm, which generally calls for meeting ambient standards. As stated earlier, ambient standards are not able to protect the environment from cumulative loadings of pollutants into it. The emerging environmental norm, total loading standards, initially calls for reducing wasteful loading into the environment. Industry would meet these total loading standards by increasing the efficiency of energy use, reducing dependence on non-renewable resources, reducing dissipative uses of toxic materials etc. In the long run (50-100 years), total loading standards would aim for closing the materials and product cycles and shifting to renewable energy resources. Closing the materials cycle would require industrial processes to move, as technically and economically feasible, to zero waste discharge, particularly of fossil-fuel-related pollutants and toxic chemicals. Closing the product cycle would require industry to manage products over their entire life cycle, from material extraction, manufacturing and use through disposal. Elements of such a policy are already in place, e.g. in the automobile industries of several countries.

51. The new approach for achieving this goal would turn the traditional approach to environmental management upside down. The current approach looks first for ways to reduce pollutants after industrial processes have already generated them. It requires the application of end-of-pipe technologies, such as waste-water treatment plants, filters on smoke stacks and the incineration or neutralization of wastes and, finally, the burial of the residue. The current hierarchy for pollutant reduction is as follows:

Final disposal
Treatment
Treatment with energy and materials recovery
Reuse and recycling
Reduction
Prevention

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*Even now it is not universally called cleaner production. In the United States, the Environmental Protection Agency calls it pollution prevention, and in the United Kingdom, the Department of the Environment retains the name clean technology.

**See 3/ for a comparison of plastic bottles and paper cartons as clean products.

52. The new approach that is emerging for environmental management reverses the priorities for management of pollutants at the firm or establishment level. The new hierarchy looks first for pollution prevention opportunities, such as product and process changes and on-site recycling and recovery, before turning to pollution abatement measures. It is as follows:

Prevention
Reduction
Reuse and recycling
Treatment with energy and materials recovery
Treatment
Final disposal

53. This new approach to environmental management is emerging for several reasons. First, industry, particularly progressive companies, is realizing that the new priorities are a less expensive and thus more profitable approach to environmental management. Secondly, it is aware that sooner or later it will be forced by Governments and public pressure to reduce pollutant loadings to the environment. Both industry and Government know that the treatment and burial approach will not meet total loading standards and sometimes not even ambient standards.

54. One example of the inability to meet ambient standards is the reduction of dioxin discharge from pulp and paper mills. The treatment of waste water will not reduce dioxin discharge sufficiently to meet ambient standards, so industry is changing its bleaching process and significantly reducing the amount of chlorine use.

55. The availability of cleaner production options, which includes both source reduction and pollution control equipment, depends on whether ambient or total loading standards are being pursued. Cleaner production options are generally available for meeting ambient standards, as is attested to by the success of some industrialized and developing countries.

56. Although cleaner production options are generally available, they may not yet be applicable to all production processes. For example, some developing countries use agricultural residues (straw and bagasse) in the pulping process. Since these raw materials have different properties from wood pulp, e.g. a higher silica content, not all cleaner production options developed for reducing the conventional water pollutants associated with wood pulping are applicable to the pulping of agricultural residue.

57. The availability of cleaner production options for meeting total loading standards, which call for significant reduction in pollutants beyond that needed to meet ambient standards, can be questioned, but there is some evidence that significant reductions are possible. A number of approaches have proven themselves useful - and, in many cases, profitable - in practical applications in the industrialized countries. This is particularly true for technologies that optimize the use of energy. 18/ Indeed, many of these technologies are not only available today but, if implemented, could realize net savings of both energy and money and simultaneously decrease the burden on the environment. 19/

58. The existing inefficiencies give an indication of potential energy savings. A comparison of energy consumption per unit of output in developing countries and industrialized countries shows that energy consumption, in

tonnes of oil equivalent, per million dollars of real GDP is 440 in the former as opposed to 290 in the latter, i.e. over 50 per cent more per unit of output (table 5). Another comparison is industrial energy consumption per million dollars of real industrial value added. On average, developing countries use twice as much energy as developed countries to produce the same output. These inefficiencies may be attributed to factors such as the improper management of the industrial production process; lack of sophisticated technologies; and wrong pricing.

Table 5. Final energy consumption and economic activity in OECD countries and developing countries, 1985

Item a/	OECD	Developing countries	Ratio of OECD to developing countries
Per capita final energy consumption, toe	3.102	0.323	9.6
Per capita industrial energy consumption, toe	1.096	0.159	6.89
Real GDP per capita, 1980 dollars	10 815.0	773	14.75
Real MVA per capita, 1980 dollars	2 769.0	289	9.58
Final energy consumption per million dollars of real GDP, toe	286.8	440.16	0.65
Industrial energy consumption per million dollars of real industrial value added, toe	276	550	0.50

Source: UNIDO, Industry and Development: Global Report 1991/92, forthcoming.

a/ Tonnes of oil equivalent = toe.

59. There are several options for achieving total loading standards for energy-related pollutants. These options include the following:

(a) Devices to control the speed of rotating process equipment such as fans, pumps and agitators;

(b) The enhancement of heat recovery from gases and liquids and the recycling of this heat;

(c) Computer-aided systems to control the temperature, flow and speed of energy etc.;

(d) Cogeneration to produce both heat and power. 20/

60. Several options are also available for achieving total loading standards for toxic chemical pollutants. These options include the following:

(a) The replacement of chemical processes by mechanical processes;

(b) The replacement of single-pass rinse processes by counter-current processes;

(c) The replacement of single-pass processes by closed-loop processes;

(d) The replacement of organic-solvent-based inks, paints and coatings by water-based ones;

(e) The replacement of mercury, cadmium and lead by other less toxic substances for pigments, catalysts, batteries etc.;

(f) The replacement of halogenated compounds by non-halogenated compounds;

(g) The installation of physical separation technologies such as ion exchange, ultrafiltration and reverse osmosis to allow the recycling of useful components;

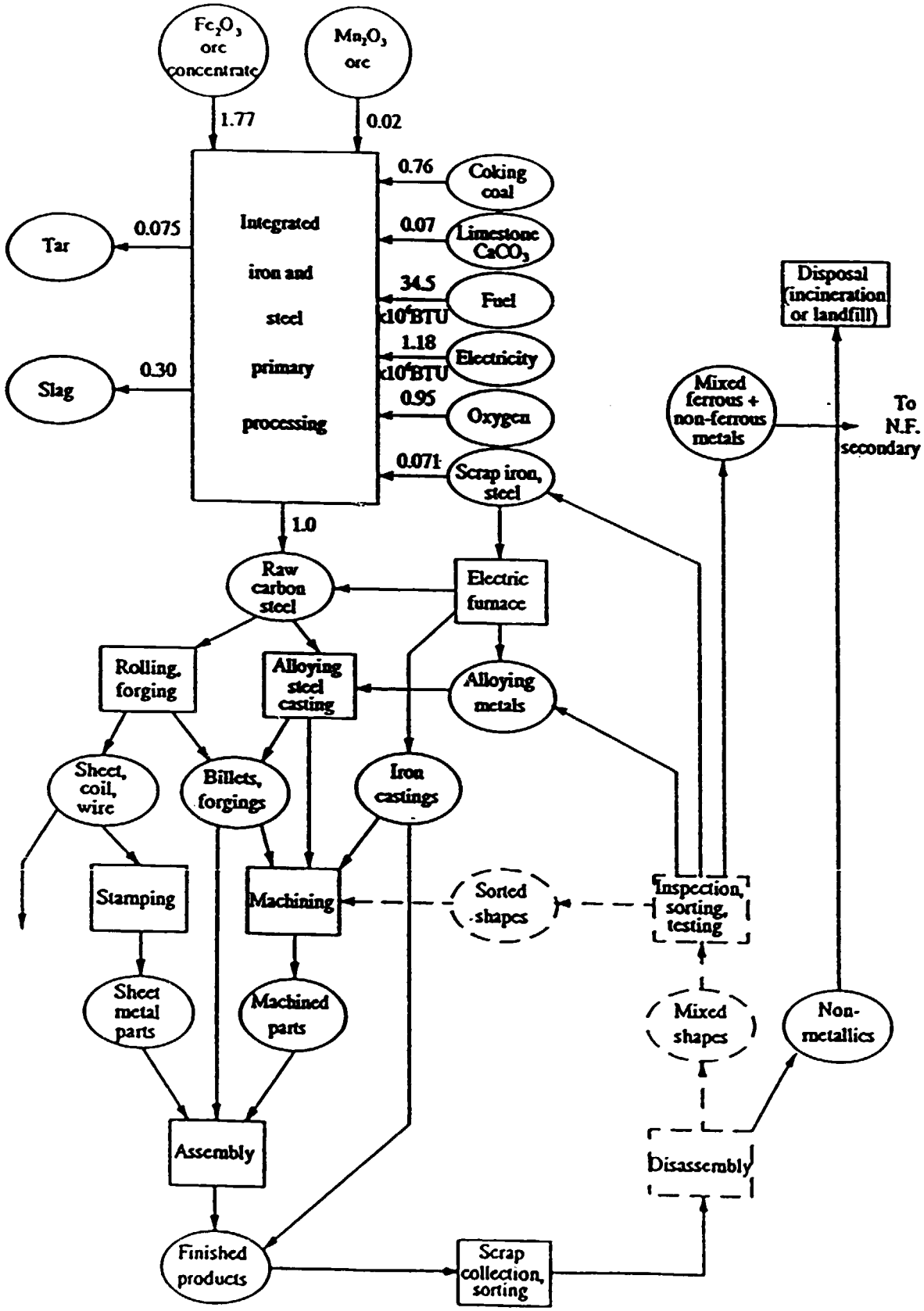
(h) The installation of more accurate sensors, microprocessors and other types of monitoring equipment. 21/

61. Many dissipative uses of toxic metals could essentially be banned by a stroke of the pen. In the case of tetraethyllead, some cost was involved: the same octane number can be achieved only at higher cost, either by the addition of alcohols or by more intensive refining and the use of greater amounts of aromatics, such as benzene, xylene and toluene. It is difficult to generalize about the cost of eliminating other dissipative uses. Many have been replaced by better substitutes (largely the case with organometallic pesticides, for instance). A few may be very difficult to eliminate, in which case the emphasis should probably be on recovery and recycling.

62. The full attainment of sustainable practices remains an open-ended task. The main difficulty is clearly in the area of recycling and remanufacturing. The closing of the materials cycle and the product cycle is essential for long-run sustainability. A brief discussion of the implications of these concepts seems appropriate at this point. Figure V illustrates the situation in the iron and steel industry. The familiar (and unsustainable) once-through sequence of materials transformation activities, beginning with raw materials extracted from the earth's crust and ending with waste residuals returned thereto, is represented schematically by solid lines. The additional generic activities that would be needed to close the materials cycle in the industrialized countries are represented by dashed lines. It is well worth emphasizing that these activities are already carried on in most of the poorer countries, although they tend to be informal, decentralized and technologically unsophisticated. Similar activities in other sectors, such as composite materials and plastics, will not be as easy to achieve. The case-study on plastics and plastics recycling describes some of the difficulties for closing the materials cycle in that sector.

63. Additional research into the potential for remanufacturing is needed because it remains an opportunity for both developed and developing countries

Figure V. The materials cycle for iron and steel



Source: R. Ayres.

that has yet to be exploited and that has significant implications for ESID. Remanufacturing may be defined as "the disassembly, inspection, refurbishing, reassembly and final testing of worn durable products, a process that renders them usable and less costly to both producers and consumers". 22/ It requires smaller capital investments and fewer labour skills than the manufacture of original equipment. In remanufacturing, the cost of energy is only 20-25 per cent that of the energy cost in original manufacture; the cost of materials is cut even more, to 15-20 per cent. In addition, recycling and remanufacturing activities will need supporting industries, such as those that manufacture measuring and automatic control devices, and they will in many cases offer new employment opportunities because they are labour-intensive.

64. The above is only part of the story, and in the long run probably the less important part. The adoption of cleaner production at the establishment level is clearly necessary, but it is not sufficient. It is increasingly clear that the world economic system must be re-oriented. There is a need to reduce dependence on fossil fuels, especially coal; the need to close the material and product cycles has already been mentioned (paragraph 49). Structural changes like these will occur only if and when appropriate economic and regulatory incentives are created. Such incentives may include resource or emissions taxes, tradeable permits, subsidies and even outright bans on certain materials. These are discussed in Working Paper IV.

VI. THE EFFECTS OF CLEANER PRODUCTION ON UNIT COSTS

65. Although neither UNIDO nor any other institution has assessed in detail the economic aspects of achieving ESID through cleaner production, fragmentary data suggest that such production would also be more efficient. Clearly, additional research is needed in this area.

66. The evidence that cleaner production measures can reduce rather than increase unit production costs and hence improve productivity is still fragmentary. To date, such measures account for only a relatively small fraction of total environmental investments in both industrialized and developing countries. Nevertheless, numerous case-studies presented in 3/ suggest that cleaner production systems can lower production costs and reduce emissions and are available for many sectors.

67. An enterprise adopting cleaner production processes may realize one or more of the following benefits while reducing industrial pollution: 21/

(a) Savings in raw materials and energy;

(b) Decreased waste management costs;

(c) Improved product quality;

(d) Enhanced productivity;

(e) Decreased down-time;

(f) Reduced worker health risks and environmental hazards;

(g) Decreased long-term liability for the clean-up of waste materials that might otherwise have been buried;

(h) Improved public image for the company.

68. A survey in the United States of more than 500 companies that adopted cleaner production processes found that each company reduced industrial wastes by between 85 and 100 per cent; even more importantly, the investment payback periods were short, only one month to three years. These benefits accrued to old industries as well as to high-technology industries. The technological changes included the incorporation of advance technologies, such as ion exchange and ultrafiltration; process modifications involving the replacement of an old substance by a new, less-polluting material; and the adoption of processes that were less chemical-intensive and more mechanical-intensive. The most dramatic case was that of the photographic firm PCA International Inc., which is included in table 6. The initial cost of $120,000 for the process modification was paid back in a few months by annual savings in the cost of developing solutions ($360,000), fixer solution ($25,000), bleach solution ($780,000) and silver recovery ($1,410,000), a total annual saving of $2,575,000. 23/

Table 6. Examples of waste reduction and payback periods of clean technologies in the United States

Industry	Method	Reduction of waste	Payback period
Pharmaceutic production	Water-based solvent replaced organic solvent	100%	< 1 year
Equipment manufacture	Ultrafiltration	100% of solvent and oil; 98% of paint	2 years
Farm equipment manufacture	Proprietary process	80% of sludge	2.5 years
Automotive manufacture	Pneumatic cleaning process replaced caustic process	100% of sludge	2 years
Micro-electronics	Vibratory cleaning replaced caustic process	100% of sludge	3 years
Organic chemicals production	Absorption, scrap condenser, conservation vent, floating roof	95% of cumene	1 month
Photographic film processing	Electrolytic recovery ion exchange	85% of developer; 95% of fixer, silver and solvent	< 1 year

Source: D. Huisingh, "Cleaner technologies through process modifications, materials substitutions and ecologically based ethical values", Industry and Environment, vol. 12, No. 1 (1989).

69. Case-studies in Europe are reporting similar findings. The Landskrona in Sweden and the Prisma projects in the Netherlands confirm results achieved in the United States. 24/

70. Although cleaner production systems are penetrating industry in developing countries, the number of applications is probably not as great as in industrialized countries, and the documentation is minuscule. There are some data, however, in the International Cleaner Production Information Clearinghouse of UNEP,* including reports on several textile mills in India. Where such data are reported, the payback is in the range of one month to a few years. Another example is a meat factory in Poland, which reports a payback period of five months for reduced water consumption and of one year for heat recovery.

71. There is, moreover, little reason to believe that meeting the requirements of ESID will require extraordinary resources, even in the case of the pollution control approach, which in the long run is likely to be more costly than the prevention of pollution through better management and technology. A recent OECD study of pollution control expenditures for eight countries with relatively complete data showed that expenditures varied between 0.8 and 1.7 per cent of gross national product (GNP). 25/ On average, countries with the most stringent environmental programmes spend about 1.5 per cent of their GNP to reduce pollutants from all sectors. On the basis of data from the United States and Germany, the manufacturing sector appears to account for about 25 per cent of the total expenditure, or about 0.4 per cent of GNP. The new approach to pollutant releases, which starts with source reduction (process and product changes) rather than pollution abatement and which emphasizes ambient rather than uniform discharge standards, would result in the manufacturing sector in developing countries spending reasonable sums on pollutant reduction to achieve compliance with ambient and total loading standards.

VII. EFFECTS OF CLEANER PRODUCTION ON EMPLOYMENT

72. The present pattern of industrialization has a limited capacity to absorb labour.** For example, a 10 per cent change in MVA in the Indian subcontinent

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*UNEP Industry and Environment Office at Paris.

**According to 26/, there are many reasons why employment growth in the manufacturing sector is falling behind both its own output growth and employment growth in the service sectors in developing countries. These include (a) widespread factor price distortions in many developing countries, such as high wage rates in modern manufacturing industries, credit subsidies to investment, overvalued exchange rates and favourable tariff treatment of imports of capital goods, all of which contribute to the adoption of more capital-intensive techniques of production in the manufacturing sector; (b) greater scope for scale economies, factor substitution and technological change in the manufacturing sector, which would lead to productivity gains and lower labour input requirements; and (c) the rigid structure of production in the service sector, characterized by a rather narrow range of factor substitution possibilities of the labour-intensive type and inefficient production processes.

resulted in only a 5 per cent change in manufacturing employment in the 1970s; this figure deteriorated further in the 1980s, when there was only a 1 per cent change in employment for a 10 per cent change in MVA.*

73. It does seem that an ESID strategy based on cleaner production has the potential for employment generation both in industry in general as well as in the environmental services sector, energy conservation and recycling and remanufacturing in particular.

74. The environmental services industry is not yet a clear-cut sector of the economy but rather a collection of companies from vastly different branches, all of whom supply goods and services used in environmental management. For this reason, data on the size of the environmental services industry are not readily available. However, a study recently completed for the United States Environmental Protection Agency showed that it is now an important factor in the economy. 27/ It is a highly diverse collection of businesses that provide about $100 billion a year in goods and services (1.9 per cent of the total economy in 1989) and employ about 2.2 million people out of a total workforce of about 120 million. Similar data are difficult to find for other industrialized countries or for developing countries. The potential for employment is there, however, as revealed in a survey carried out in Latin America. 28/ The survey concluded that regional demand for environment-related equipment will expand at not less than 10 per cent, on average, in the 1990s, a rate similar to that in developed countries in the 1980s.

75. The implementation of energy efficient technologies to achieve ESID offers yet another opportunity for employment generation. As cited in 29/, a report published by the Council on Economic Priorities concluded that investments in energy efficiency, conservation and solar technology provided more than twice as much employment as new energy sources. It found that "at the local level, where saving from efficiency improvements would be recirculated in the economy, a dollar spent on energy efficiency produced four times as many jobs as one dollar invested in a new power plant". 30/ Another study, conducted in 1985 by the Commission of the European Communities, reached the same conclusions. 31/ A look at table 7 clearly shows that renewable technologies in fact generate more employment than conventional technologies.

76. Similarly, recycling and remanufacturing have the potential to generate new jobs. One study that reviewed remanufacturing in the United States in light of its implications for developing countries concluded that it would open up significant employment opportunities for low-skilled and moderately skilled workers: "Despite the fact that remanufacturing serves to recapture labour that does not have to be duplicated, the activity itself is labour intensive and furnished employment for a range of labourers, especially those with moderate skills". 22/ Remanufacturing can also offer jobs to those

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*UNIDO calculation. To some extent, these findings understate the employment generating capacity of the manaufacturing sector in developing countries. They fail to take into account the substantial secondary effects of industrial investment resulting from interindustry purchases of inputs and income-induced effects of private consumption.

workers who have been displaced by technological innovations. A study that reviewed recycling from municipal refuse cited several examples of employment and income being generated by recycling activities in developing countries. 32/

Table 7. United States direct employment generated by electricity-producing technologies

Technology	Jobs (per terawatt-hr per year)
Nuclear	100
Geothermal	112
Coal a/	116
Solar thermal	248
Wind	542

Source: Lester R. Brown and others, State of the World 1991: A Worldwatch Institute Report on Progress Toward a Sustainable Society (New York, Norton, 1991).

a/ Includes coal mining.

VIII. APPROPRIATE ROLES

77. Whatever specific goals and actions are agreed to achieve ESID, it will require cooperation among industry, government, trade unions, citizen groups and international organizations.

A. Government

78. The key actor in the framing of an effective environmental policy for industry is the Government, which has the power both to set standards and to choose from a wide range of instruments to implement such standards. The Government must create a realistic framework for encouraging industry to pursue cleaner production processes.

79. This framework should integrate the environmental dimension into industrial policy and all spending programmes relevant to industry. It should eliminate policy inconsistencies and mismanagement, as well as policies and instruments that distort markets, e.g. the fixing of wrong prices (artificially cheap energy or raw materials). It should also correct market failures, such as the absence of prices for environmental services. Governments should generally adopt the polluter-pays principle, which requires industry to bear the cost of pollutant reduction and prevention. This principle, if implemented through economic incentives and through constant monitoring by public administration and the legal system, would apply continuous pressure on industry to pursue cleaner production options and would prevent distortions of competition among firms. Last but not least, the Government should stimulate environmental awareness of the general population.

B. Industry

80. No environmental policy will be truly effective if entrepreneurs, who have the final responsibility for meeting environmental objectives, do not cooperate. Whether an industry is owned by the State or is private is not central to this point, although the structure of incentives will be different depending on the form of ownership. In the past, industry has mostly been reactive to environmental regulations. It must now seek out ways to transform and apply technology in a way that diminishes environmental deterioration. It must commit itself to the concept of cleaner production, which requires it to look at the entire life cycle of its production process. It must submit to environmental audits, which can provide both the entrepreneur and the public with information on the progress made in implementing cleaner production processes.

C. Trade unions

81. Trade unions and worker associations can make an important difference in achieving ESID through cleaner production processes. Workers, if encouraged, can directly identify opportunities to improve production processes. Trade unions ought to include environmental issues in their agreements with management, because cleaner production processes usually result in a safer working environment and increase the competitiveness of their company.

D. Citizen groups

82. Citizen groups relevant to ESID are mainly consumer groups and non-governmental organizations concerned with the environment. Consumer groups, largely spearheaded by women, can influence the environmental impact of industrial production by preferring products whose production, use and disposal result in less environmental damage. If the pressure of consumer groups is great enough, industry will respond by changing process methods, e.g. by introducing low-waste packaging and recycling. By scrutinizing industrial activity, non-governmental organizations concerned with the environment can apply pressure on Governments to institute effective environmental enforcement programmes and on industry to meet environmental norms.

E. Transnational corporations

83. Transnational corporations are playing a major role in the structural redeployment from North to South. They are the source of much of the technology for reducing emissions and for cleaner production. As the transfer of technology involves the private sector, it is obvious that legitimate property rights need to be protected. This is all the more true since what is being transferred is not only hardware but also such things as training for the maintenance and operation of the equipment in line with codes of practice.

F. International agencies

84. Since achieving ESID is a matter of global interest, international agencies such as UNIDO must identify activities and assist in their implementation on a regional and global scale. International agencies also have an important role in assisting developing countries in the design and implementation of national policies that promote ESID. The diffusion and application of cleaner production processes in developing countries, which would

help them to avoid the past mistakes of industrialized countries, needs to become a major part of the future work programmes of UNIDO. This should be done in close cooperation with development finance institutions and bilateral assistance agencies, which make available funds for ESID-related projects, as well as with the new funding mechanisms such as the Interim Multilateral Ozone Fund, established under the Montreal Protocol, and the Global Environment Facility, jointly managed by UNEP, the United Nations Development Programme (UNDP) and the World Bank.

IX. CONCLUSIONS

85. The traditional pattern of industrial development is not sustainable over a long period because it threatens the basic conditions of life support on earth by placing at risk the ozone layer, the global climate and key cycles of nature, including the deposition and use of oxygen, carbon, nitrogen, phosphorus and sulphur. Industry is a major cause of the present disequilibria in the biosphere. It is a major source of the energy-related pollutants CO_2 and SO_2 and a significant source of toxic chemical releases to the environment.

86. While in the past industry in developed countries has been the largest contributor to these problems, developing countries will increasingly become involved as they continue to industrialize. There is a strong positive correlation between energy and raw material consumption and industrial output in developing countries. If present trends continue, the share of global air pollutants and toxic chemicals emitted by developing countries will increase significantly in the years to come.

87. To avoid further risks to the biosphere and to the sustainability of the industrial development process, the world needs new patterns of industrialization. These new patterns of industrialization, ESID, must be ones that enhance economic and social benefits for current and future generations without impairing the basic ecological processes. ESID would be characterized by (a) limitations on industrial activities to protect the biosphere; (b) the efficient use of man-made and natural capital; and (c) in the social sphere, equity as a basic principle in the transition to a sustainable society.

88. UNIDO believes that the key to achieving ESID is the introduction and broad application of cleaner production methods. Cleaner production looks to all aspects of the product life cycle. Cleaner production is at once two things: (a) a new environmental quality goal and (b) a new approach for achieving that goal. The new goal would require industry to move beyond meeting ambient standards to stabilizing and then reducing total loadings of pollutants of global concern. The new approach would turn the traditional environmental management scheme upside down by assigning priority to source reduction (product and process modification), recycling and reuse as the primary options for mitigating the environmental impact. Conventional pollution control technology, while it would still be used, would in the longer run be replaced by prevention technology.

89. As pointed out previously, the adoption of cleaner production technologies at the establishment level is only part of ESID. It is perhaps even more important, in the long run, to initiate major changes in the structure of the world economic system. These necessary changes include (a) sharply reduced

dependence on fossil fuels, especially coal, and (b) sharply reduced dependence on non-renewable mineral resources, especially toxic heavy metals ("closing the materials cycle"). These changes cannot be accomplished solely by direct command and control methods. Rather, the relevant economic incentives under the control of governments (taxes, tariffs, subsidies and institutional arrangements) must be re-examined and modified appropriately.

90. Developing countries, which in many cases are still at the beginning of the industrialization process, have a unique opportunity in adopting cleaner production. They have a chance to introduce technologies that are more resource-efficient and less disruptive of the environment than the existing technologies used in developed countries. Moreover, it is significantly cheaper to incorporate cleaner production methods when new plants are being built than to introduce such methods in existing plants.

91. The mutuality of interests between developed and developing countries in achieving ESID through cleaner production provides a compelling argument for North-South cooperation and for supporting South-South cooperation. Many cost-effective measures for reducing threats to the biosphere that are possible in the South will not take place unless the North expands its technical cooperation (transfer of knowledge and expertise) and its financial assistance. Managing the transition to an ecologically sustainable economy should involve all sectors of industry and should be done on the basis of clear targets, appropriate time-frames and financial incentives to support the transition process.

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BARRIERS FACING THE ACHIEVEMENT OF ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

Working Paper No. II

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CONTENTS

INTRODUCTION

1. In working paper No. I, entitled "The road to ecologically sustainable industrial development", the concept of ecologically sustainable industrial development (ESID) was discussed. Working paper No. I included a proposal to adopt a slightly more complete definition of ESID than the one offered by the World Commission on Environment and Development: patterns of industrialization that enhance economic and social benefits for present and future generations without impairing the basic ecological processes. It was suggested in working paper No. I that industrialization contributes to the enhancement of benefits if it is directed towards:

(a) Limiting industrial pollutants within a critical load beyond which they would adversely affect human beings and nature (eco-capacity), thus ensuring the quality of human life and the proper management of natural assets;

(b) Maximizing industrial output from a given level of resource input (efficiency), thus ensuring the appropriate use of human, renewable and non-renewable resources and minimizing waste;

(c) Ensuring that all countries have and continue to have a fair chance to participate in the industrial process, thus sharing the wealth generated by industrial activity (equity).

2. Following from the definition and characteristics of ESID provided in working paper No. I and summarized above, the present working paper looks at barriers to achieving ESID. Section I contains a description of information deficiencies that limit people's understanding of the environmental consequences of unsustainable development practices. Section II presents an examination of access to cleaner production technologies needed to attain ESID.

3. Sections III-IV provide a discussion of specific barriers that are preventing the introduction of cleaner production programmes from achieving ESID. These barriers are those most relevant to industry itself (section III), those resulting from inappropriate or non-existent government action (section IV), those resulting from international conditions (section V) and those resulting from the absence of citizen participation in societal decisions (section VI).

4. Finally, section VII contains a summary of the barriers hindering the achievement of ESID.

5. A word about the limitations of the present working paper are in order at this point:

(a) The literature on barriers to achieving sustainable development and to technology transfer in particular is vast. This working paper is not a survey of that literature; instead, it identifies some of the major barriers to achieving ESID-related objectives, which admittedly will require considerable transfer of information from the North to the South;

(b) There is no unique way to classify barriers to achieving ESID. Consequently, the barriers listed in one section could have as easily been put in another;

(c) Many of the specific barriers are encountered in developed as well as developing countries. An attempt has been made in the present working paper

to take this into account and to focus on the problems encountered by developing countries because the purpose of the Conference on ESID is to assist industry in developing countries in understanding ESID-related requirements and in formulating appropriate policies and strategies.

6. While this working paper highlights barriers to the adoption of cleaner technologies in developing countries, it must be noted that developed countries have not adopted such technologies as quickly as they could. Four brief examples from Denmark and the United States of America, countries with the financial resources and technical and scientific talent to implement cleaner production programmes, underscore this point:

(a) Waste reduction: The United States Office of Technology Assessment (OTA) estimates that 50 per cent of all environmentally harmful industrial wastes could be eliminated with the technology that was available in 1986 and that another 25 per cent with additional research and development (R and D); 1/

(b) Pollution abatement expenditures: It is evident that the diffusion of cleaner technologies is still limited. In 1985, about 20 per cent of the United States expenditure for pollution abatement was for process modifications. This percentage has remained more or less constant in previous years. Thus, the remaining 80 per cent was of "end-of-pipe" pollution control character, which means a fairly limited penetration of cleaner technologies; 2/

(c) Energy intensity: In 1985, energy intensity (the ratio between the energy consumption and industrial output) in the industrial sector was higher in the United States than in several other countries of the Organisation for Economic Co-operation and Development (OECD) (France, Germany and Japan), in spite of the existence of energy conservation technologies that could markedly improve the situation; 3/

(d) Cleaner technologies: Even in Denmark, only about one third of industry has adopted "clean" technologies. 4/

Thus, the opportunities for improvement in the adoption of cleaner production technology are poorly utilized, even in developed countries.

I. ENVIRONMENTAL INFORMATION DEFICIENCIES

7. Only recently has society come to realize that pursuing environmentally unsound practices will in the long run undermine the achievements of economic growth. Although the World Commission of Environment and Development reached some consensus on this issue, there are still many parties pursuing unsustainable practices because they are not convinced that their actions will have long-term detrimental consequences. They are not convinced that practices such as discharging mercury into regional seas or releasing particulate matter in densely populated areas will significantly affect human health and the environment, as there are non-systematic or inadequate data on the status of environmental degradation and the linkage of pollutant discharge to that degradation.

8. Environmental information deficiencies include limitations on the nature and extent of environmental degradation (physical indicators of resource depletion as well as air, water and land pollution); limited understanding of the proximate and underlying causes of, and hence feasible remedies for,

environmental degradation; limited understanding of the physical consequences of resource depletion and environmental degradation; and insufficient measurement of the economic losses resulting from environmental degradation.

9. Admittedly, there are some data on the nature and extent of environmental degradation. One can turn to the Environmental Data Report 1991/92 5/ of the United Nations Environment Programme (UNEP), World Resources 1990-1991 6/ of the World Resources Institute for a global overview, to the OECD publication The State of the Environment 7/ and to State of Environment in Asia and the Pacific 1990 8/ of the Economic and Social Commission for Asia and the Pacific (ESCAP) for a regional overview and to certain country reports, primarily from developed countries, for a general assessment. What is really missing are systematic data on the contribution of industries, primarily in developing countries, to environmental degradation in different geographical areas, data that are specific enough to result in the modification of industrial activities.

10. For some pollutants, such as conventional air and water pollutants, there is a reasonable understanding of the relationship between pollutant discharge and environmental deterioration and of the measures needed to reduce that impact. For other pollutants, such as toxic heavy metals and persistent organic pollutants, much less is known about their impact on the environment, particularly on aquatic ecosystems, and about the most cost-effective measures needed to reduce their environmental impact. For global pollutants, primarily greenhouse gases, there is considerable uncertainty about the degree and extent of their impact and the measures needed to slow down that impact.

11. In most situations, there is limited understanding of the physical consequences of resource depletion and environmental degradation. The scientific community does not know the extent to which the cumulative loading of acid deposition will affect the productivity of aquatic and terrestrial ecosystems, such as forests, and how in turn those changes will alter hydrological regimes, nor does it understand the long-term impact of heavy metal accumulation in regional seas, such as the Mediterranean.

12. Lastly, there is insufficient measurement of the economic losses or damage resulting from environmental degradation. In some developed countries, such as Germany and the Netherlands, environmental damage has been estimated at 1 per cent and 5 per cent, respectively, of gross national product (GNP). 9/ Estimates of environmental damage in developing countries are not yet available, except for selected natural resource losses such as soil erosion and deforestation. The estimates of natural resource losses range from 0.4 per cent to 9.0 per cent of GNP. Such estimates are especially needed for urban areas in several developing countries with severe air pollution problems. There are few quantitative estimates of the excess morbidity and mortality or monetary estimates of the medical costs and pain and suffering associated with these problems.

II. ACCESS TO CLEANER PRODUCTION OPTIONS

13. While the lack of information on, high costs of and limited access to clean technologies are often cited as key obstacles to ESID, these factors may be less critical than commonly supposed, at least for certain types of industry and certain levels of environmental protection. Further, there are many cleaner production options that involve simple ("good-housekeeping") measures that cost little but can be very beneficial to the environment. In

this section, the barriers to cleaner production technologies and technology transfer will be discussed, along with obstacles to new and emerging technologies.

A. Access to existing cleaner technologies

14. The accessibility of technologies for cleaner production processes is of the utmost importance to developing countries wishing to achieve ESID. These technologies are essential for meeting emerging global environmental concerns, as well as for dealing with local environmental pollution resulting from conventional pollutants.

15. Barriers that limit access to technology and the transfer of environmentally sound technology include lack of information and misconceptions about technology; suitability of technology to developing countries or to certain types or sizes of industry; existing limitations of some technologies; costs of technology; lack of skilled personnel; uncertain legislative and regulatory climate; and cultural factors. Other factors, which are discussed later, include problems with the existing international patent system; the slow rate of new investment in developing countries, which lowers the rate of diffusion of new technologies; a slanted approach to clean technology transfer as implying high-tech end-of-pipe technology; and the tendency of technology transfer to hinder the development of endogenous technological capacity.

1. Lack of information and misconceptions about technologies

16. Often information on environmentally sound technologies exists, but getting the information to the decision maker in the right place and at the right time in the most useful form can often be a problem. Thus, while the information may be available, vehicles for communicating the information may not be adequate. 10/ Sales material and instruction manuals written for and in the North, for example, are often not suitable for use in the South. This problem can be particularly acute for small-scale industry and/or for industries employing significant numbers of women. It is well known, for example, that women's access to technology, credit and training is limited compared with that of men, and this may lead to women utilizing fewer clean technologies since they lack the information and means to push for and secure more modern equipment.

2. Suitability of technology to developing countries

17. Misconceptions about technologies can also present problems. For instance, many clean technologies were designed to suit conditions in developed countries. Thus, many of the technologies exported to developing countries may not be easily adapted to the conditions, infrastructure and environment in developing countries. There is also a paucity of R and D in developing countries on solutions suited to those countries. To illustrate, certain process technologies may need continuous inputs for optimal production functioning and may break down if a batch approach is used; however, in many developing countries, batch-feedstock is a more realistic possibility than continuous feeding for several types of production activities. 11/ Thus, identifying good means of communicating cleaner technologies, as well as communicating the critical factors needed by developing countries to make informed choices, must take place to ensure effective technology transfer.

3. Limitations of existing technologies

18. The availability of cleaner production options, which cover both source-reduction and pollution-control equipment, also depends on the level of ESID sought. In working paper No. I, it was pointed out that the transformation of industrial processes in the direction of ESID must be incremental. Technology exists and appears to be available for meeting ambient standards, generally speaking, through "good-housekeeping" measures and basic pollution-control technology, as well as pollution-prevention measures.

19. Many cleaner production options for meeting ambient standards exist already; others have to be developed. Two examples of key processes from the pulp and paper industry - wood pulping and agricultural residues pulping - illustrate this point. In wood pulping, almost all stringent limits can be met by implementing modern technology. Discharges of chlorinated organic compounds from bleaching and malodorous sulphur compound emissions from kraft pulping, however, cannot be reduced by available technology to meet stringent ESID norms. It is expected, though, that by the year 2000 it will be possible to achieve a sustainable level of bleaching discharges.

20. In agricultural residues pulping (straw, bagasse), cleaner production choices are more limited owing to specific properties of these raw materials (e.g. high silica content), and not all clean production options developed for wood pulping are applicable to agricultural residues pulping. By the year 2000, it will not be possible to reduce biochemical oxygen demand (BOD) and suspended solids in agricultural residues pulping as drastically as in wood pulping. 12/ This implies that cleaner production technologies, even more than pollution-control technologies, to a large extent have to develop or be adapted endogenously.

21. Thus, the availability of cleaner production options for significant reduction in pollutants beyond that needed to meet ambient standards can be questioned, but there is some evidence, as presented in working paper No. I, that significant reductions are possible. The move to where the full attainment of sustainable practices is achieved, by total loadings standards as described in working paper No. I, remains, and will continue to remain, an open-ended task. In this regard, the major difficulty is obtaining information to initiate and implement recycling and remanufacturing.

4. Costs of acquiring technology

22. Section III, especially the subsection on costs of acquiring cleaner production technology, provides useful insight on costs of technology transfer as well. Capital costs of new, cleaner technology processes are frequently greater than "polluting" technologies. The present economic problems of developing countries, compounded by large debt burdens, may make it difficult for them to secure resources for (a) acquiring cleaner technologies or (b) building their own endogenous capacity for assessing, adapting and developing environmentally sound technologies. 10/ It should be pointed out, however, that a number of simple "good-housekeeping" measures can be adopted and implemented at very low cost, such as preventive maintenance schemes to avoid leakages and break-downs and the proper handling and use of chemicals.

5. Uncertain legislative and regulatory climate

23. The absence of a legislative framework or, more commonly, the lack of enforcement or enforceability of existing legislation hinders technology

transfer, creating uncertainty for prospective investors and discouraging foreign or national investment in technology. Uncertain political situations and policies on nationalization and privatization can also militate against the transfer of technology through foregone foreign investment or joint ventures. 11/

6. Lack of trained personnel

24. Education and training may be the most important requirements for successful technology cooperation. Countries with adequate numbers of well-educated managers and workers have been more successful in mastering transferred technology. 13/ The human resource base must be able to analyse, assess, acquire, absorb, master and develop cleaner technologies. Maintenance of highly capital- or skill-intensive technologies is impossible without the associated technological know-how and human resources. 14/

25. Even in developed countries, production engineers do not take easily to the idea of incorporating clean technology into original industrial process designs, partly because it requires a sophisticated understanding of the interaction between technological and environmental systems. Engineering education and training are only now changing so that basic engineering courses, as well as engineering design and research, reflect the ESID approach.

7. Cultural and religious factors

26. Countless books have been written about what happens if technology is imposed wholesale on a completely different culture without regard for important cultural values and characteristics. As one example, changes are needed in Islamic countries to adjust to the holy month of Ramadan with dawn-to-dusk fasting, necessitating, for example, changes in production and shift schedules. 11/ Another example, one that has already been mentioned, is the need to involve women more by exposing them to more information on clean technologies.

B. Access to new and emerging technologies

27. Technological advances in fields such as biotechnology, microelectronics, solar energy and recycling, which cut across industrial sectors, have much to contribute to ESID. Biotechnology can provide ecologically sound products and processes and help the bioremediation of wastes and toxic substances and the conservation of biodiversity. Its processes require far less energy than thermo-chemical processes, e.g. for leaching metals or for manufacturing chemical products. Materials engineering reduces the consumption of materials, thereby helping to conserve natural resources and ensuring savings in energy consumption, as well as in wastes and emissions. The advantages of solar energy, from an ecological point of view, need no elaboration. What then are the barriers to the diffusion of these new and promising technologies?

28. Technologies in these fields are often skill-intensive, quickly commercialized and, because of continuing advances, quickly obsolescent. Considering the market size and the investments needed for R and D and for production, developing countries need to be selective and to apply the new technologies in those areas where they are best suited. For this purpose, developing countries must strengthen their technolcgical capabilities over the long term.

29. The various barriers to the utilization of technological advances are basically not different from those discussed so far, though issues of patent protection and access are even more hotly debated. Moreover, awareness of the potentials and implications of the technological advances is lacking in many developing countries and a policy framework for the assessment and introduction of the advances does not exist.

30. In biotechnology, for example, the building up of capabilities in advanced techniques such as genetic engineering is important. Knowledge in the field of biotechnology is being increasingly privatized. The capacity for efficient commercial-scale bioprocessing is lacking in many developing countries. Regulations relating to biotechnology safety are environmentally essential, as in the case of other chemical processes, but excessive and cumbersome controls could become a barrier to production and trade within and between countries.

31. Production of new materials in developing countries faces constraints of market size, but advanced techniques of materials engineering can be applied to new as well as traditional materials, including biomass and other local resources. Increased attention needs to be given to testing and evaluating new materials and to setting up standards. Composite materials generally result in less use of materials but the recyclability of some of the composites is in question. The materials field as a whole can be channelled more and more in the direction of ESID.

32. Microelectronics provide products and processes that save energy and replace mechanical parts. Monitoring and control of pollution are rendered easier. It is applicable over a wide range of industries. The capacity of developing countries to produce software for various applications is a constraint. The production of microchips involves the use of toxic materials and it is now well recognized that adequate safeguards are necessary. The use of microchips, however, poses no environmental problems.

33. In the case of solar energy, particularly with solar photovoltaics (PV), the costs are coming down. Since 1973, the price of PV electricity production has decreased from $US 15 per kilowatt hour (kWh) to $US 0.30 per kWh. 15/ (The newest solar thermal power stations already compete with new coal- or oil-fired plants.) Larger market size for PV cells would reduce the costs further and make it a viable energy option not confined to isolated sites and applications. Market surveys could be a starting-point but the main emphasis has to be on expanding the size of the market by development of appropriate products and systems. Hence, more attention has to be given to design and also to the production of balance of system components (auxiliary equipment) connected with solar photovoltaics. The capacity for building PV systems is therefore of particular importance. This gives special scope for systems engineers and engineering and design consultants, who are generally in short supply in developing countries.

34. Energy supply that does not damage the environment can in the long term only be based on renewable energy sources. Hydrogen can be used for the production of heat and electricity and as a transportation fuel. Its use, however, is still much at the research stage and requires technical development for cost reduction, especially if it is linked with solar energy. Its use would also require changes in energy delivery systems.

35. Micro-electronics is not the only emerging technology viewed as having a large potential for energy conservation: the next generation of heat-pumps,

super heat-pumps, will be able to recover low-grade heat, which is currently being wasted; 16/ chemical vapour deposition, a technique for layering thin coatings of materials on surfaces, might greatly decrease the cost of solar power, improve the energy efficiency of homes and offices and increase the speed of computers; 17/ and there are prototype cars that are five times more fuel-efficient than other cars. 18/

36. Absence of sustained funding over the long term for both research and application has been a barrier for many new technologies. This is especially true for solar and other renewable energy technologies where investment in research has fluctuated with world oil prices.

37. Recycling technologies exist in large measure but their cost-effectiveness and the organizational efforts to collect waste are factors to be considered. Increasingly, biodegradable materials are being used for packaging. New technologies for recycling plastics, notably polystyrene, are currently under development, primarily to reduce the amount of plastic packaging material going into landfills. In general, however, the recycling/reuse issue is one of scale and organization, as well as of technology. The exception to this statement may be in the area of design and disassembly of vehicles, appliances and machinery. There, the recovery efficiency and quality of all kinds of materials can be improved to permit the remanufacture of generic components, such as gearwheels, axles and engines. This change calls for genuinely new technologies. Their systematic development has only recently commenced.

38. The use of advanced technologies in the service of ESID in a forward-looking context is therefore an area that needs increased attention. International cooperation in a range of generic and precompetitive research is needed to harness technological advances for the development and application of environmentally sound technologies.

III. INDUSTRY BARRIERS

39. Within the industrial community, a number of barriers hinder acceptance and adoption of ESID. These barriers include attitudinal obstacles, labour barriers, patent and property rights, the need for better trained personnel, costs of acquiring technology, and costs of operating and using technology.

A. Attitudinal barriers

40. Changes in attitudes of the entire industrial community, not to mention Governments and the public, are essential for effecting the shift from short-term thinking towards a longer-term sustainability outlook. Industry's attitudes, like those of the rest of society, once laboured under simplistic thinking, seeing a dichotomy between jobs or the environment rather than seeing them as inextricably linked. In terms of environmental protection, industry and Government both saw dilution as the solution to pollution.

41. The limitations of the dilution approach quickly became evident to industry and Government alike. Pollution control, or focusing on end-of-pipe technology, was the next orientation and this approach has preoccupied government environmental agencies and industry alike for years. Even with sophisticated pollution-control equipment, there are still wastes to be disposed of at high costs, filters and scrubbers to be cleaned and so on.

42. Another shift in industry's attitudes is currently taking place, driven by the recognition that pollution prevention is the solution. This way of thinking recognizes that reducing resource waste has both economic and environmental benefits. 19/ It requires that corporate decisions incorporate a total ("cradle-to-grave") life-cycle approach into the design of products and production processes.

43. This comprehensive ESID or cleaner production approach has been pioneered by a few firms and has been found invaluable from a business as well as an environmental standpoint. One firm estimated that by using that approach, it saved nearly $US 506 million in a 15-year period. 20/ So why are more industries not adopting the approach?

44. Looking at the tanning industry, found in many developing countries, two attitudinal barriers must be overcome to encourage adoption of cleaner production techniques: the first is simple resistance to changing what works ("if it isn't broken, don't fix it") and the second is a limited perception of the environmental harm caused by tanning. If a tanner is consistently producing a quality of leather that satisfies his or her customers, he or she may be reluctant to make changes to comply with environmental demands. 21/ Furthermore, traditional tanning is a mixture of art and science, and adoption of a low-waste technology may radically alter the traditional process with which the tanner is comfortable. Since many tanneries are marginal operations, some tanners may feel that, by adopting such a technology, they may be jeopardizing their entire operation.

45. Knowledge among tanners of the actual environmental harm caused by tanning also appears to be quite limited. Tanning in most developing countries is a family operation, run by people with little formal education using skills passed down from one generation to the next. The elders may have little perception of environmental protection concerns. 21/

46. In 1982, a United States researcher on waste reduction presented what he saw as the principal obstacles to waste reduction. Specifically, he suggested that 60 per cent of the obstacles were political, with technical obstacles constituting only 10 per cent of the stumbling blocks. Of the political barriers 20 per cent were attributable to bureaucratic resistance and 10 per cent to human conservatism (see table). 22/ Thus, the reluctance to change, even after new processes or technologies have proven successful, underlines the importance of not underestimating attitudes and the role that they play in hindering change or speeding acceptance.

47. The attitudes of women in industry deserve mention here. Since close to 200 million women are employed in industry, especially in light industries (electronics, food processing and textiles) and in low-paid, unskilled jobs, their attitudes toward ESID and potential as change agents must be considered. As low-skilled workers, they are among the most likely to be directly exposed to toxics and on the front line in terms of their role in taking action to cause or limit environmental damage. If their creativity can be mobilized, some great strides can be made - with the adoption of fundamental steps such as monitoring and "good-housekeeping" practices. Furthermore, as women play a crucial role in most societies in socializing current generations and educating future generations, giving women information on ESID approaches and the means of promoting ESID could be especially effectiv-

Obstacles to waste reduction

Obstacle	Share (percentage)
Political in nature	
Bureaucratic resistance	20
Human conservatism (resistance to change)	10
Piecemeal legislation	10
Media sensationalism	10
Public ignorance and misinformation	10
Total	60
Financial in nature	
Disposal "subsidies"	10
Scarce money	10
Entrenched disposal industry	10
Total	30
Technical in nature	
Lack of centralized reliable information	5
Lack of assistance with the application of waste reduction approaches to individual needs/uses	5
Total	10

Source: D. Huisingh, "Cleaner technologies through process modifications, material substitution and ecologically based ethical values", Industry and Environment, vol. 12, No. 1 (January-March 1989), p. 5.

B. Patent and property rights

48. Patent rights constitute another barrier that is frequently cited, albeit in general terms. Reportedly, the price set for patents can be too high for the local market in developing countries. But information is lacking on how serious and widespread a problem this can be in hindering the adoption of cleaner technology or the transfer of technology. One reason that the barrier of patent protection may not be as serious as previously thought is that few of the environmentally sound technologies under patent protection actually restrict their availability in developing countries. 10/ An exception to this may be in the biotechnology area, where companies are patenting processes and technologies to protect their investments.

49. Some technology development, including the development of cleaner technologies, is undertaken by public R and D institutions. These public domain technologies may only require multilateral and bilateral exchanges and

clearing-house mechanisms to ensure their timely transfer. 10/ According to an ongoing OECD survey of trade barriers to the adoption of eight clean technologies, intellectual property rights are rarely an obstacle to the diffusion of clean technologies. 23/

50. Nonetheless, the rationale advanced for patent protection cannot be dismissed; inventors must be adequately rewarded so that incentives exist for sustained effort in new R and D. The balance between an incentive system that promotes R and D and rewards inventors and a system that ensures developing countries access to cleaner technologies must be considered. 8/

C. Labour barriers

51. Although many cleaner technologies are not very advanced, their potential impact on labour can hinder a firm from making the change. For example, replacing the transportation of red mud from aluminium production by trucks with a pipeline to the storage area can have significant social disadvantages; the resulting unemployment of a number of truck drivers may be seen as socially untenable for the business in question. 24/

52. In the case of a modern pulp and paper mill capable of meeting present environmental norms and of adjusting to more stringent ESID norms by the year 2000, the fact that such a mill will employ a much smaller workforce is a definite obstacle to the construction of such mills in developing countries. The new mills would consolidate the production at several small mills, resulting in loss of employment and community disruption.

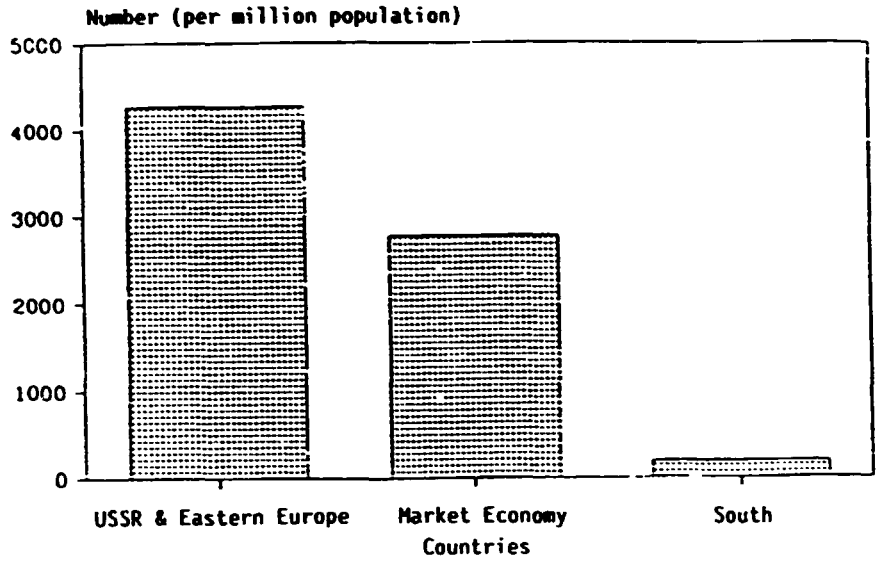
D. Lack of trained personnel

53. Another barrier faced by industries interested in adopting cleaner technologies is the lack of trained personnel to analyse, adapt, operate and maintain newer technologies. As indicated in section II, many cleaner production technologies are skill-intensive. Sometimes training can make the difference between a cleaner technology being profitable or not. In aluminium production, the use of burnt lime for reducing caustic soda losses (mud causticizing, complex causticizing etc.) requires special operating and analytical skills. The processes are usually profitable only within a narrow range. Insufficient amounts of lime do not have the expected effect; too much may cause extra alumina losses. Reluctance to pay proper attention to these processes (especially during afternoon and night shifts) can nullify all positive results of the causticizing. Workforce training and incentives are essential. 24/

54. The need to build up capabilities in advanced techniques such as genetic engineering is also vital. But there are few microbiologists in developing countries and they require advanced training.

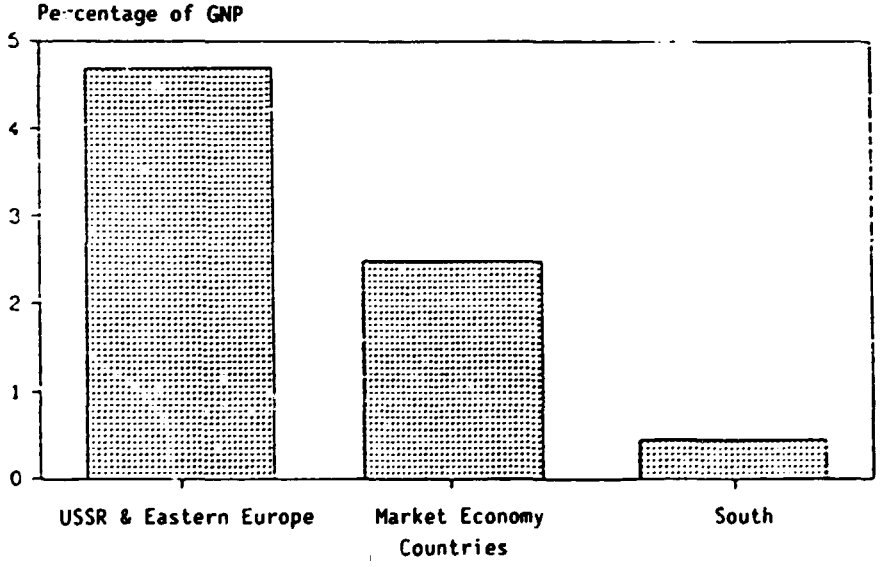
55. A serious impediment, particularly for developing countries, is the absence of a critical mass to assess and adopt cleaner production techniques. Although there are no specific data on the scarcity in this particular area, there are data on the absence of commitment in developing countries to science and technology. As evident in figures I and II, expenditure on R and D as a percentage of GNP and the number of scientists and engineers per million population are much lower in developing countries than in either planned or market economies.

Figure I. Number of scientists and engineers per million population in the North and in the South



Source: The Challenge to the South: the Report of the South Commission, forthcoming.

Figure II. Expenditure on R and D as a percentage GNP in the North and in the South



Source: The Challenge to the South: the Report of the South Commission, forthcoming.

E. Lack of quality control

56. The lack of quality control procedures in some firms can be an obstacle to achieving full benefits from a clean technology. When a laboratory is not directly under the jurisdiction of plant management, it appears that control

methods degrade. One example of the link between quality control and "good-housekeeping" measures is alumina production: it has been found that simply more careful operation and maintenance can save 1-2 per cent of caustic soda consumption. 24/

F. Costs of acquiring cleaner production technology

57. The costs of acquiring cleaner production technology, especially capital costs, can be prohibitively high in the case of certain technologies, smaller enterprises, older plants and certain industries (see section II). The perceived costs, however, are often not as high as the actual costs, particularly when other operating and pollution control costs are taken into account. And some cleaner production options simply require adoption of "good-housekeeping" measures.

58. With virtually no new investment and with the involvement of thoughtful and creative managers and workers, a number of "low-tech" changes are possible. For example, a textile mill at Bombay, India, increased the collection rate of the caustic soda from its mercerizing wash waters from 75 per cent to 85 per cent and the recovery rate from 81 per cent to 90 per cent by more efficient washing, better filtration, correcting leakages and seapage, and other corrective measures. Net savings of 415 kg of caustic soda per day resulted in an estimated savings of 684,750 rupees per year. 25/

59. Considerable strides have also been made in containing pollution from leather tanning simply by adopting measures that require little or no capital investment such as:

(a) Strict process control, including avoidance of overdosing of chemicals;

(b) Water conservation at all stages of wet processing;

(c) Introducing reuse-recovery-recycle systems that can save expenditure on chemicals and, in turn, pay for the simple equipment needed to run them, such as collection pits, pipes and pumps.

60. It is believed that strict process control, "good-housekeeping" measures and cleanliness, the introduction of recycling of some floats, and predominantly aqueous finishing, together with simple treatment of wastes, may result in the elimination of nearly 50 per cent of the total pollution load discharged into the environment, with only a marginal investment. 26/ This illustrates that cost need not be a barrier to adopting cleaner production techniques. Additional examples are discussed in working paper No. III.

61. For some small-scale businesses, however, such as family tanners, the cost of introducing cleaner technology is a very real barrier. The price of the special drum for "hair" recovery with the necessary auxiliary equipment may be as much as twice the price of a conventional drum. 21/ As another example, the much-touted high chrome exhaustion tanning method requires expensive specialty chemicals, normally proprietary products. 21/ In the pulp and paper industry, price fluctuations of chemicals such as caustic soda and chlorine may act against the implementation of clean production options. As caustic soda prices increase more rapidly than chlorine, some mills tend to reduce caustic soda changes, thus increasing residual lignin and using more chlorine in bleaching. 12/

62. Another financial barrier is higher interest rates on borrowed capital in developing countries. Tanners in developing countries may have much more capital tied up in work-in-progress because they frequently experience delivery delays and shortages and, consequently, need to keep higher stocks of chemicals and machinery spares. 21/ Thus, obstacles such as higher interest rates and more "tied up" capital further hinder the adoption of newer, cleaner technologies.

63. Cost need not always be an obstacle. Some multinational corporations have transferred technology at no cost to manufacturers in developing countries. The Industry and Environment Bureau of the International Chamber of Commerce cites a case where a small company in a Gulf State, which was electroplating designs on aluminium cans, had difficulties with trace metals in the wastewater. The Bureau, through its contacts, found a member that had developed a system to handle the trace metals and passed it on to the Gulf manufacturer at no cost. 27/ Thus, where there is no commercial conflict of interest, technologies can be offered at little or no cost.

64. Import duties on chemicals and machinery can be another barrier to the use and maintenance of cleaner production technology. Duties vary tremendously from country to country and can run as high as 100 per cent. 21/ Regulations pertaining to import duty on imported equipment present serious economic barriers to the adoption of cleaner technologies in developing countries. In India, the import duty for paper machinery is 40 per cent. There are similar restrictions in Brazil. 12/

65. Efficient alumina plants, which extract nearly all available aluminium oxide content, require both better facilities (capable of applying a higher digestion temperature) and a more sophisticated process control system. Both involve capital costs ranging from $US 10 million to $US 100 million, depending on plant capacity, which represent a very real economic barrier to the adoption of cleaner production. The replacement of worn-out equipment after 20-30 years of operation, however, offers a good opportunity for such modernization. Such changes are long overdue in older plants in China, India and some other developing countries. 24/

66. Though larger firms may be able to afford some cleaner production technologies, smaller firms, which are more common in developing countries, may not. For instance, in China, the budget for a pulp and paper chemical recovery system for a large-capacity mill is estimated to be $US 4.5 million. Many smaller mills simply cannot afford such an investment. 12/ One way to overcome this problem is for small- and medium-scale enterprises to undertake joint efforts in areas such as resource recovery and waste treatment.

G. Size and maturity of firms

67. One of the difficulties most often cited in the literature is related to the characteristics of firms and the structure of industry. In particular, a firm's absorptive capacity for technical change is seen to be related to the size and maturity of the firm and industry in question. A firm in the early stages of its growth cycle tends to be flexible in its choice of production methods and, hence, can be receptive to new processes. As the firm becomes mature, however, it becomes moulded to certain established manufacturing practices. As a result, the production system becomes more inflexible and technical changes tend to be marginal. For instance, paper and pulp in France, leather tanning in the Netherlands and sugar refining in the United Kingdom of Great Britain and Northern Ireland are all mature industries that

have shown some resistance to new process technologies and that have preferred "end-of-pipe" approaches to pollution abatement. Resistance to technical change caused by the ossification of industry structure, however, may be less relevant in a large number of developing countries, where most of the manufacturing industries are either at embryonic stages of development or are yet to be developed.

68. The size of firms may affect significantly their capacity to absorb new technologies regardless of the stage of development. The small size of firms may prevent them from adopting clean technologies, even if they are aware of such opportunities, since they cannot afford the capital outlay, the modernization required, or the attendant risks of using new technologies. They are not capable of undertaking any large-scale R and D and, hence, become technically dependent on outside sources. Such limitations of small- and medium-sized firms are likely to be even more serious in developing countries. 14/ As an example, many of the cleaner production technologies for pulp and paper were developed primarily for larger mills. Scaling down would result in lower efficiency, such as heat consumption and chemical recovery efficiency. 12/

IV. GOVERNMENT BARRIERS

69. At the national level, there are several barriers to the adoption of ESID-related measures. These barriers include policy failures, legislative/regulatory failures, and problems caused by government management of enterprises.

70. Failure to pursue ESID-related actions, strategies and activities is attributable to many factors, many of which are often intertwined and mutually reinforcing. At the national or government level, it is important to distinguish between policy and legislative/regulatory failures.* Policy failures are government interventions, such as misdirected industrial policies and resource pricing distortions, in reasonably well-functioning markets. Legislative/regulatory action is needed where markets do not function adequately. The absence of market prices for environmental services and resources is one such example.

A. Policy failures

1. Industrial policy

71. Most developing countries have, over the last 40 years, pursued a policy of industrialization, in which industrial activity has received subsidies of various kinds, ranging from protection, in the case of import substitutes, to incentives, in the case of exports. Much of the production that takes place in this framework is inefficient, in the sense that it entails higher true costs than the same products produced in developed countries. Government controls the technology used in the sector, indirectly through its protectionist and subsidy policies and more directly through its regulation of the

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*This distinction and the discussion that follows are based on T. Panayotou, "Economic incentives in environmental management and their relevance to developing countries", Environmental Management in Developing Countries, proceedings of the Conference on Environmental Management in Developing Countries, Paris, 3-5 October 1990.

activities of transnational corporations. The overall "success" of such industrialization programmes has been mixed, with high growth rates in export-oriented sectors and relatively low rates in import-substitution- oriented sectors. Although higher industrial growth rates have been found in some countries, in almost all of them the capacity of the sector to absorb labour has been limited. In India, industrial output rose by 6.7 per cent per annum in the period 1968-1984, while employment rose by only 2.9 per cent per annum during the same period. 28/

72. The environmental implication of this is that, with a growing population, much of the environmental damage with which developing countries are faced is related to the unsustainable use of natural resources by a population that does not have access to alternative income-generating activities. It would be unfair to lay all the blame for environmental degradation in the agricultural sector on the inability of the industrial and other sectors to create employment opportunities, but there is something to this argument, as has been pointed out by a number of writers.* Hence, the question that should be asked is whether the whole policy of ESID does not need to be seen in the light of a need to maintain higher employment in the economy and to stabilize population growth, thereby relieving the pressure on the resource base. This need is met not only by developing a highly capital-intensive, "modern North-based" industrial sector. There will always be a role for such a sector, but it needs to be accompanied by a labour-intensive industrial sector, where the benefits are in part the avoided environmental damage caused by an over-populated and underemployed rural economy that colonizes marginal land or puts pressure on the Government to permit the exploitation of forest land for agriculture.

73. A number of developing countries have adopted policies that make it difficult for a local firm to license foreign technologies, with the aim of stimulating local entrepreneurial creativity to find substitutes. The results, however, are mixed. The rapid growth in industry and in exports in East Asia shows that flexible protection of the domestic market is not inconsistent with export success. In several Latin American countries, however, industries sheltered by heavy and indiscriminate protection have no incentive to look for export markets. As clean technologies may be developed further once they have been introduced, there may well be a case for countries making exceptions in their protection policies for some of these technologies.

2. Sectoral policy

74. Governments may also hinder ESID by targeting or emphasizing certain sectors for special support (through fiscal, trade or other reductions or incentives) without considering the environmental implications of such support. Sectoral policies that do not take into consideration the environment may result in Governments failing to close down inefficient industries or to require appropriate environmental processes and controls on new industries. In many cases, these sectoral policies tend to support the most polluting

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*See, for example, A. Markandya, "Technology, environment and employment", ILO Working Paper No. 216, Geneva, 1991, and D. W. Pearce and J. Warford, "Environment and development", World Bank mimeo. Although this link between a lack of employment opportunities and environmental damage has been made many times, it is only fair to point out that there are few detailed studies to support the proposition and, in general, the quantification of the links is virtually non-existent.

industries. Most of these growth sectors are industries that are highly resource-intensive, using large quantities of water, energy and raw materials, and concomitantly highly pollution-intensive, creating a diversity of pollutants and industrial wastes, including toxic chemicals. The following four industrial sectors grew twice as fast in developing countries as a whole compared with developed countries in the period 1980-1985: iron and steel; nonferrous metals; nonmetallic minerals; and chemicals. 29/ Because of the rapid growth of these industries, arising in part from explicit government support for such industries, industrial development in the countries concerned may become ecologically unsustainable more quickly than expected.

3. Pricing policy

75. Government pricing policies (e.g. subsidies, taxation, overvalued currency) may lead to distortion in the behaviour of industries, which in turn contributes to both government financial burdens and environmental degradation. A classic case is the underpricing of wastewater-related services and energy resources. For example, many industrial establishments discharge their wastewater into public treatment systems. These systems do not charge industry for using their services, according to many surveys, including a recent one by UNIDO (ID/WG.507/9 (SPEC.)). As a result, industry uses too much water in its production processes, forcing the public treatment works to build unnecessary capacity. In the energy area, for example, China and Egypt have low levels of power tariffs, which have not been adjusted for three decades. 30/ Consequently, the energy intensity is higher in these countries than it needs to be and the discharge of energy-related pollutants is greater than it needs to be. Another case is the use of accelerated depreciation for end-of-pipe pollution-control equipment. This tax advantage discourages the use of process change, which builds permanent pollutant reduction into the production process.

B. Legislative/regulatory/coordination failures

76. Several problems hinder implementation of ESID within and across government institutions in developing and developed countries. These include poor integration of environmental and economic policies, legislative shortcomings, poor enforcement capability and poor environmental management.

1. Poor integration of environment and economics

77. The segregation of government economic and development policies and agencies from their environmental policies and agencies presents a serious barrier to ESID implementation. Even in environmentally conscious developed countries, economic planning takes place without consideration of the environmental implications of such planning. Another barrier is the relative weakness of many environmental protection agencies. Without a voice in the formulation of national economic plans, environmental agencies are in no position to ensure the integration of environment and economics. Environmental agencies themselves, as well as environmental legislation and regulations, will also need reform and change, as many are oriented towards "single-media" effects (e.g. air pollution) and pollution control rather than towards "multi-media" effects (e.g. air, water and soil pollution) and pollution minimization. 31/

2. Inappropriate strategy

78. Even functioning environmental management agencies in developed and developing countries can create obstacles to ESID by making pollutant reduction costs higher than they need be. First, they tend to be "single-medium"-oriented, regulating air, water and waste discharges separately from industrial facilities. They discourage "multi-medium" pollutant reduction plans because their legislative statutes are "single-medium"-oriented and comprehensive pollutant reduction plans are difficult for their current organizational structures to assess. Secondly, they tend to encourage end-of-pipe rather than source reduction and recycling/reuse as the way to reduce pollutant discharge. End-of-pipe technology is the known solution that environmental (civil) engineers learn in universities; it provides visible evidence that a plant has made an effort to reduce pollutants. Thirdly, they tend to require all industries of a similar type to meet uniform discharge standards regardless of the surrounding ambient conditions and unique circumstances (such as size and production costs) that would allow cost-effective reductions. All of these factors contribute to making pollutant reduction costs much higher than they have to be to achieve ambient standards. Even though OECD data show that spending on pollution control is a small percentage of GNP, in the range of 1-2 per cent, such spending could have been even lower if environmental management agencies had pursued over the past 20 years an integrated pollution prevention strategy that had focused on cost-effective pollutant reductions. 32/

79. In the enforcement arena, when standards are enforced and fines are large enough, companies will often invest in new technologies (since the cost of complying is less than the cost of being in violation). But without adequate enforcement, a significant incentive is missing for inducing firms to adopt cleaner technology. Thus, standards that are not enforced, often because of a lack of personnel, are another serious obstacle to Governments carrying out their responsibilities for implementing ESID. 33/

80. Many developing countries have failed to create regulatory regimes to implement their legislation. A world-wide survey by the World Health Organization (WHO) in 1985 highlighted the lack of the basic elements of a regulatory programme. 34/ Of the 59 moderately to rapidly industrializing countries, only 10 had most of the key programmed components, 29 had some and 20 had little or none. Not one of the 76 less industrialized countries had any significant institutional capacity in environmental management. A survey by UNIDO in 1990 of industrial wastewater management in seven African countries showed that, although all seven had some form of legislation or statute, only one had the essential elements of a regulatory programme (ID/WG.507/9 (SPEC.)).

C. Government-managed enterprises

81. Major industrial enterprises in developing countries are often nationalized public companies with a record of political rather than economical management resulting in a history of chronic losses and of serious environmental degradation. Many Eastern European enterprises are also wrestling with the negative effects of poor public management, although information on this problem is just beginning to emerge. These sectors watch carefully for problems associated with public sector management and especially the apparent reluctance of such groups to take environmental considerations.

V. INTERNATIONAL BARRIERS

82. At the international level, at least three barriers impede the implementation of ESID: the financial crisis of developing countries, compounded by the failure of developed countries to bear their share of ESID implementation; the terms of international trade; and the inherent limitations of sovereign States.

A. Financial crises

83. In the 1980s the financial conditions of developing countries deteriorated because of high interest rates and volatile exchange rates, the reduced volume of net resource flow to these countries, the sharp drop in commodity prices leading to further decline in their terms of trade, and an increasing level of protectionism.

84. Real interest rates (excess of nominal rates over expected inflation) in major industrial countries increased sharply between 1979 and 1982: long-term interest rates increased from -0.3 to 7.5 per cent per annum and short-term interest rates rose from 0.7 to 6.8 per cent per annum. After reaching a peak in 1982, real interest rates have fallen slightly. They have, however, remained until now at a historically high level, i.e. significantly above the range of average real long-term rates for major industrial countries in the period 1952-1965 (1.5-3.0 per cent per annum). This contrasts sharply with the period 1976-1979, when this rate was only 0.9 per cent per annum. 35/

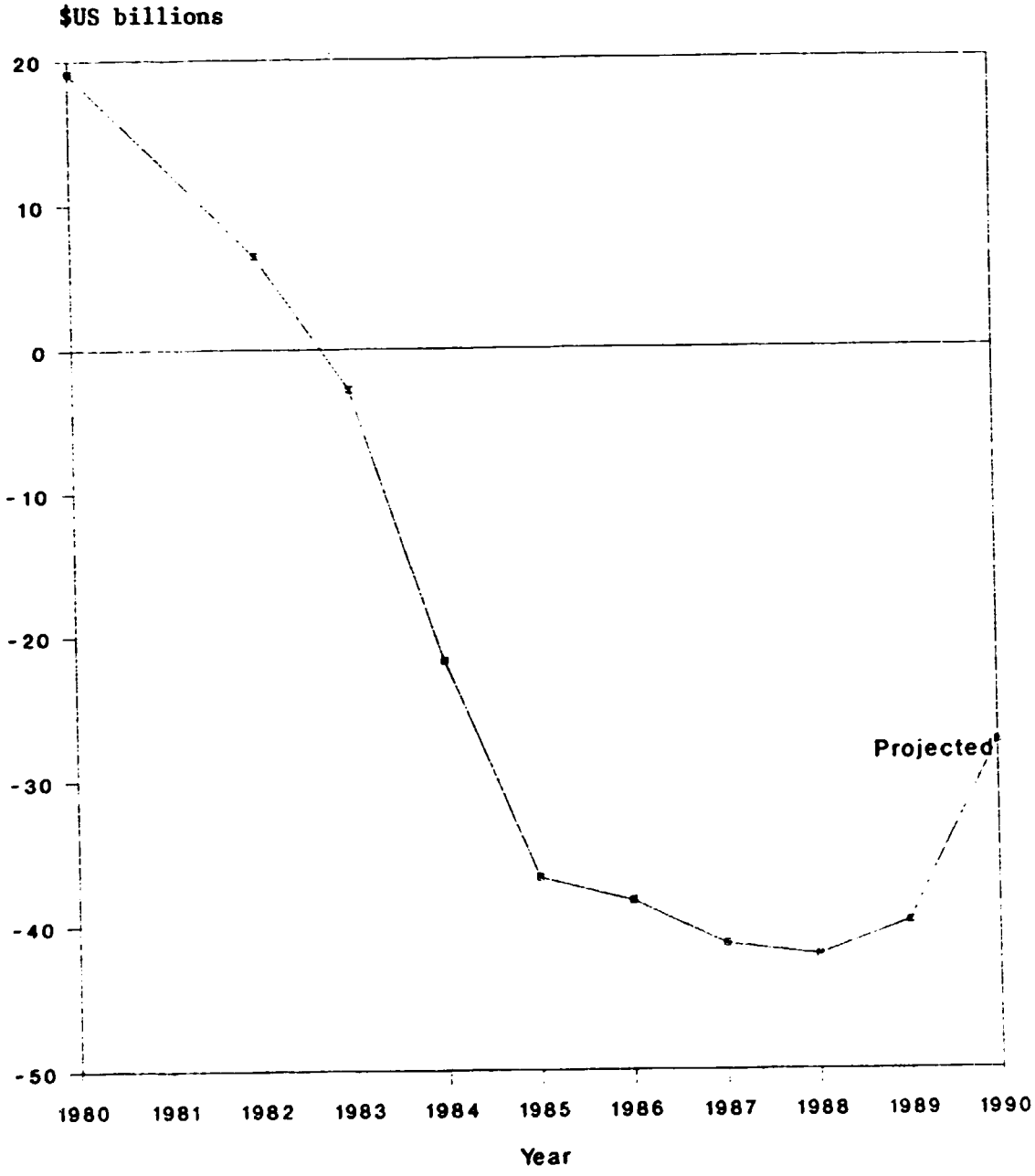
85. Increased interest payments, accompanied by drastically reduced debt-related flows (disbursement of loans minus principal repayments), resulted in an extremely negative trend of debt-related transfers (debt-related flows minus interest payments on long- and short-term debt) for developing countries in the 1980s. Whereas in 1980 debt-related transfers were still significantly positive ($US 19.1 billion), in 1983 the debt service repayments of principal and interest charges of developing countries already exceeded loan disbursement. Debt-related transfers have remained negative for developing countries as a whole since then; the total volume of such transfers amounted to $US 250 billion for the period 1983-1990. 36/ Although by far the most significant was the negative transfer from developing countries to commercial banks in industrial countries in the North, there was even a net transfer from current borrowers to the World Bank in 1988 and 1989. Figure III illustrates the trend of net transfer on debt-related transfers by developing countries in the period 1980-1990.

86. Direct foreign investment in developing countries also declined in the first half of the 1980s, while the outflow of profits remained consistently higher than the inflow of new investments until 1986. From 1987 on, however, transfer of financial resources channelled through direct foreign investment again became positive for developing countries as a whole, as the continued interest of foreign investors in investing in Asian countries was supplemented by renewed interest in Latin America.

87. To sum up, the reversal in the direction of debt-related transfers and the only slight recovery of direct foreign investment transfers in recent years, combined with practically stagnating official development assistance in the 1980s, resulted in a sharp fall in aggregate net transfers to developing countries in that decade. Whereas aggregate net transfers of long-term resources were positive for the South as a whole until 1983, they were negative for every year from 1984 to 1989. For Latin America alone, the total

volume of such transfers amounted to over $US 110 billion in the period 1984-1989. 37/ If data for short-term interest payments were to be included, negative aggregate net transfer figures would be significantly higher.

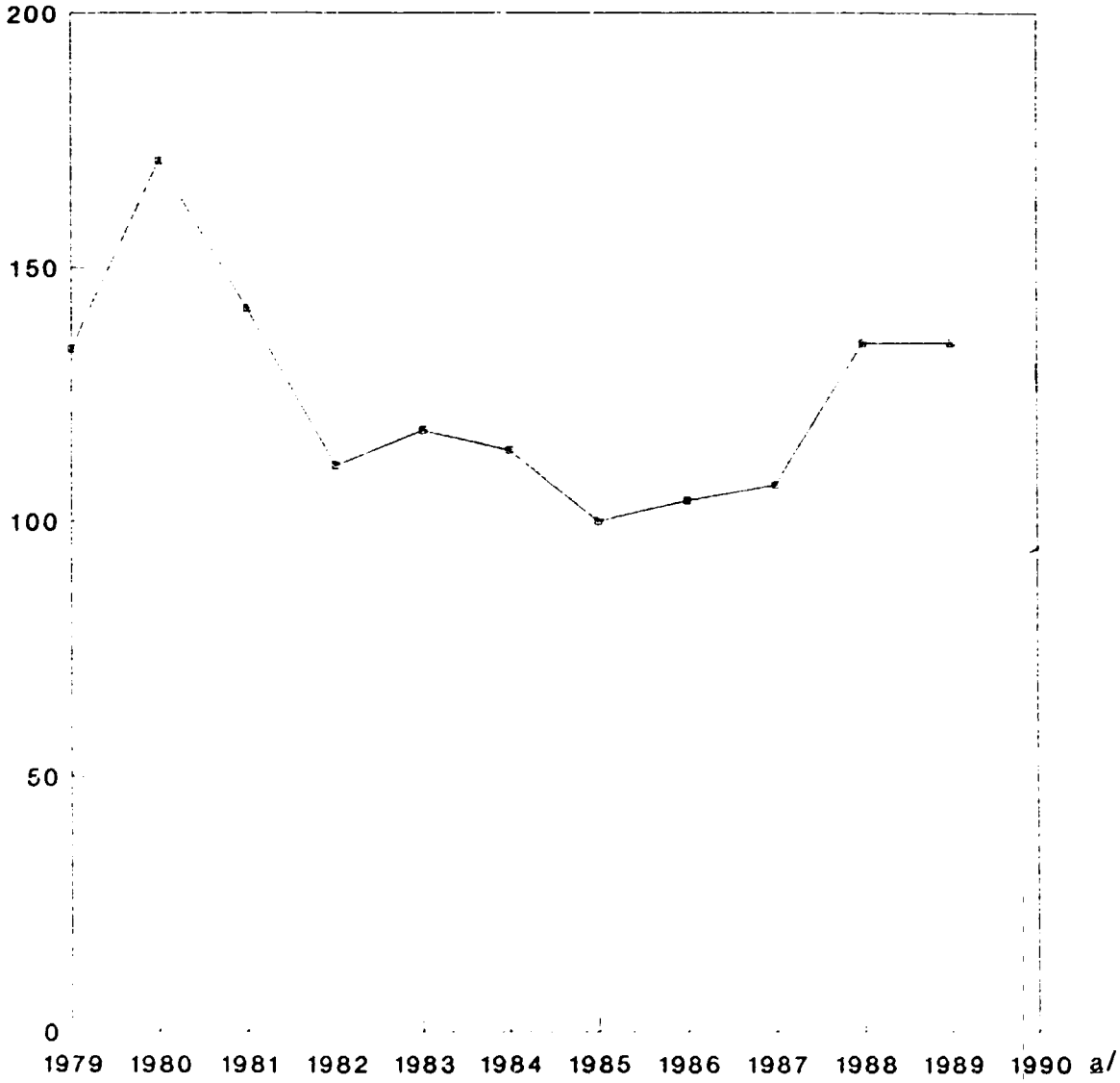
Figure III. Net debt-related transfers, developing countries, 1980-1990



Source: World Bank, World Debt Tables 1990-91: External Debt of Developing Countries: Volume 1. Analysis and Summary Tables (Washington, D.C., 1990), p. 126.

88. Commodity prices also declined in the 1980s (see figure IV). In 1990, the prices of non-fuel commodities exported by developing countries (combined index) were 25 per cent lower than in the beginning of the 1980s, whereas the fall in food commodities was even greater: 36 per cent. 38/ As a result of declines in commodity prices and increases in manufacturers' prices, the terms of trade of developing countries as a whole have deteriorated significantly since 1980. There have been, however, differences between the various regions of the South. While the terms of trade of selected developing countries in Asia have not actually changed much, they have dropped to around 25 per cent in the case of developing countries in the western hemisphere and in sub-Saharan Africa and to about 50 per cent in the case of Middle Eastern countries.

Figure IV. Price indices of prime commodities, 1979-1990
(1985 = 100)



Source: UNCTAD Commodity Yearbook 1990 (United Nations publication, Sales No. E.90.II.D.9), table A.1.

a/ First seven months only.

B. Trade policies

89. There are several trade barriers that may impede the achievement of ESID: tariff and non-tariff barriers, production and export subsidies, and trade agreements. One of the basic issues underlying trade and the environment is the way environment policies can result in trade distortions and trade policies can lead to negative environmental results.

1. Tariff and non-tariff barriers

90. Tariff and non-tariff barriers, whether intentional or not, can impede the transition to ESID. For example, restrictions on market access (the quota system) can force countries to increase the production of pollution-intensive or natural-resource-intensive goods because they cannot capture other product markets. Faced with domestic and external financial problems, many developing countries resorted to pollution-intensive sectors in the 1980s. Increased protectionism in OECD countries reduces market access for non-traditional goods from developing countries and hence prevents their diversification into more ecologically sustainable activities.

91. Another set of trade restrictions may be imposed by OECD countries in their demand for "green" characteristics in products. 39/ Some members of the General Agreement on Tariffs and Trade (GATT) want to set up a special committee to look at environmental trade issues. They are opposed by some developing countries that fear that environmental protection may become one more reason for excluding some products.

92. There are more and more cases that illustrate the above-mentioned problem. One such case is the controversy between Mexico and the United States over the import of tuna from countries that catch 25 per cent more dolphins than United States fishermen. GATT has tended to oppose attempts by any one country to impose production standards on the production process of its trading partners. Measures are emerging, however, that will affect production processes. The Montreal Protocol on Substances that Deplete the Ozone Layer, adopted on 16 September 1987, allows countries to ban not only the imports of chloro-fluorocarbons (CFCs), but also products either containing them or manufactured by processes using them.

93. Tariff and non-tariff barriers in OECD countries are partly responsible for unsustainable patterns of commodity trade contributing to increases in deforestation, desertification, wetland degradation and unsustainable land use. Tropical timber is a frequently highlighted case: limited access to the processed woods markets in developed countries have contributed to developing countries' increased production and export of unprocessed timber to earn foreign exchange. 14/

2. Production and export subsidies

94. All Governments take measures to enhance the competitiveness of their goods and services in international markets through subsidies for production and export. This can also cause environmentally unsound distortions, by encouraging greater production in certain sectors rather than in others that are environmentally more sound. Developed countries continue to subsidize certain sectors such as shipbuilding, mining, steel, textiles and automobiles, even though these are sectors where developing countries could establish a comparative advantage and, through the use of cleaner production processes, could pursue more environmentally sound alternatives.

95. Despite general principles adhered to by most GATT members, subsidizing is still practised, leading to price and market distortions. These include export credits and guarantees, tied (conditional) aid and offsets. Export supports are common in such sectors as steel, transport equipment and construction, resulting in overcapacity and an uneven geographical distribution of output.

3. Trade agreements

96. Most trade agreements fail to treat the environmental factor adequately. This is true of bilateral agreements involving automobiles, steel and textiles and of voluntary export restraints, voluntary restraint agreements and orderly marketing agreements. It is also true of free trade agreements (common markets, regional agreements etc.) where concerns have been raised about the environmental impact of trade liberalization measures. While free trade agreements can improve overall levels of trade, they can also lead to the movement of pollution-intensive industries to environmentally sensitive geographical areas and can limit the use of economic measures for environmental management. They can also result in the weakening of environmental regulations and standards. In the case of the United States, while the "fast-track" authority sought by the President will allow for more flexibility in trade negotiations, it can also reduce the likelihood that environmental issues will be scrutinized appropriately.

97. Preferential trade agreements between developing and developed countries, for example, the Generalized System of Preferences, the Africa-Caribbean-Pacific/European Economic Community (ACP/EEC) Convention signed at Lomé on 8 December 1984 and the United States Caribbean Basin Initiative can also divert trade in environmentally unsound directions and cause environmentally unsound structural adjustment in developing countries.

98. Finally, trade-related investment measures (TRIMs) and trade-related intellectual property rights (TRIPs) need to be assessed in terms of their environmental implications. TRIMs can impede investment in ESID by discouraging foreign investment through exchange restrictions, local input requirement and profit repatriation restrictions; however, they can also be used by Governments to encourage environmentally sound investments.

C. Limitations of sovereign States

99. Sovereign States may ignore regional and global externalities that result in damage being done outside their borders. They are reluctant to take the measures needed to achieve ESID if such measures will infringe on their sovereign powers or will require them to incur a substantial portion of the costs to protect a resource of international importance.

100. This situation is all too evident from the difficulties associated with achieving global and regional agreements. Admittedly, some progress has been made, as evidenced by the Montreal Protocol, which required some last-minute concessions to developing countries before it could be ratified. But will developed countries be willing to contribute between $US 20 billion and $US 40 billion so that a similar agreement may be reached on greenhouse gases? 40/

101. Even among industrialized sovereign States, there are few examples of successful regional environmental accords that have actually resulted in pollutant reductions. It took Canada and the United States over 20 years to

reach an agreement on reducing acid deposition even when pollutants from each of the countries were affecting the other, and it will take them another 20 years to achieve a significant reduction in the pollutants in question. In Europe, there is now an agreement to reduce by 1993 sulphur dioxide emissions by 30 per cent (based on 1980 emission levels), but clearly additional reductions are needed.

VI. COMMUNITY PARTICIPATION

102. There is an emerging recognition of the importance of community participation to ensuring that societal decisions move the process of industrialization towards ESID. For too long, government authorities and large industrial organizations have controlled the direction of industrialization. Consequently, they have been able to ignore the consequences of their actions on the environment, such as the displacement of populations or the exposure of communities to excessive health risks from pollution.

103. To counter this situation, particularly in developed countries, citizens have organized non-governmental organizations (NGOs) to challenge centralized governmental organizations and large industrial organizations. These NGOs demand that Governments enact and enforce environmental laws and question the business practices of large industrial establishments. They have succeeded to a large degree in influencing government decisions, as evidenced by the enactment and enforcement of more stringent environmental laws. They have succeeded to a lesser degree in influencing industry, but this situation is changing, as evident in the statements of business leaders at the Second World Industry Conference on Environmental Management, held at Rotterdam from 10 to 12 April 1991.

104. Industry is responding to environmental concerns for various reasons: in the United States, citizens now have much more information on pollutant discharge as a result of the Toxic Release Inventory; and in Europe, there are strong green consumer movements, such as the Blue Angel labelling programme in Germany. Even a well developed green movement, however, can go only so far unassisted, according to a recent assessment of the green movement. "Neither green consumers nor green investors are substitutes for government intervention. Their influence is too random, too poorly informed, to provide consistent pressure on companies to take the most cost-effective steps to be cleaner." 41/

105. NGOs are only now emerging in some developing countries and often are not as powerful as NGOs in developed countries. Nonetheless, linkages between government institutions and NGOs are improving in developing countries, and rapid progress was made in the late 1980s. In Indonesia and the Philippines, strong government policies support the activities of NGOs. One barrier to stronger community involvement in developing countries appears to be a lack of government policies explicitly providing support to NGOs.

VII. SUMMARY

106. The mere abundance of barriers to ESID and the difficulty in judging their relative importance must not itself become a barrier. Although information deficiencies hinder efforts to find the most cost-effective paths to ESID, the evidence of the seriousness of environmental degradation at the

global, regional and local levels calls for an immediate start for a fundamental restructuring of industrial activity.

107. The transition has to start from within industry. Comprehensive waste-reduction or pollution-prevention programmes engaging employees at all levels have proved profitable for small and large companies in the North as well as in the South. Starting with low- or no-cost measures such as "good-housekeeping", raw material substitution or process modification, such programmes have the potential to by-pass the financial constraints common in all developing countries.

108. Governments have to make sure that pollution prevention is profitable. Environmental agencies should pursue a multi-media pollution-prevention approach as opposed to the more common single-media end-of-pipe strategy. Enforcement of environmental regulations is crucial.

109. Any kind of government measure to protect or stimulate domestic markets or subsidize export sectors must be flexible, so that it does not to deprive industry of incentives and foreign technologies necessary to achieve ESID.

110. Although existing technologies offer vast possibilities for moving towards ESID, attention also has to be given to new and emerging technologies such as biotechnology or solar energy, which offer solutions to many environmental problems. Many new and emerging technologies are skill-intensive. Developing countries with a shortage of skilled personnel must therefore be cautious and selective in their choice of application of these technologies. A noteworthy point is the close relation between expenditure on R and D in solar energy and world oil prices. It shows that the lack of market prices for environmental service is the fundamental barrier to ESID. For example, a global carbon tax could do a lot to pave the way for a clean renewable energy technology.

111. All the problems associated with technology transfer in general are also barriers to ESID, since many of the technologies needed for long-term sustainability will have to be transferred. The strengthening of technological capabilities to assess, adapt and develop technologies to suit local conditions is vital to developing countries in the long run.

112. Patent protection is undoubtedly needed as an incentive for sustained efforts in new R and D. Although frequently cited as a barrier in general terms, there is little evidence that the current patent system is a major barrier to the transfer of clean technologies.

113. The move towards ESID is incremental. It has to start from within industry and it needs the support of Governments and the public and international cooperation. The difficulties encountered in achieving and implementing global environmental agreements is perhaps the most serious barrier to ESID.

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Auditing for Cleaner Production

In preparation for Cleaner Production efforts, detailed analysis and planning is required. One of the fruitful innovations in this field has been to borrow the methodology of financial auditing.

In co-operation with UNEP and with funding from the Norwegian Government, UNIDO has recently prepared an Audit and Reduction Manual for Industrial Emissions and Wastes as a practical guide to this work.

Waste audits provide detailed accounts of processes and wastes, energy audits focus on the flow and transformation of energy in the production system, while environmental auditing spans the whole range of a plant's environmental effects and compliance with regulations.

Waste audits aim at identifying waste by detailed analysis of the individual processes in the chain and suggest methods for eliminating or minimizing it. Instead of cumbersome and expensive end-of-pipe treatment of large volumes of dilute wastes, attention is moved up the pipe to the component processes in the production chain. Based on audit results, the different waste streams - the different waste substances from different sources - can be kept separate, which is a requirement for successful treatment and recycling.

INDUSTRY INITIATIVES IN ACHIEVING ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

Working Paper No. III

Contributions to this document have been made by Dr. G. Winter of the German Environmental Management Society, (BAUM), Hamburg, Dr. R.G.A. Boland (Consultant) and Mr. T. Davis, International Network for Environmental Management.

Contents

Explanatory notes

BAUM German Environmental Management Association
BCSD Business Council for Sustainable Development
CFC chloro-fluorocarbon
CP cleaner production
EPA Environmental Protection Agency (of the United States of America)
ESID ecologically sustainable industrial development
ICC International Chamber of Commerce
IPCS International Programme for Chemical Safety
IEO Industry and Environment Office (of UNEP)
ILO International Labor Organisation
INEM International Network for Environmental Management
ISO International Standards Organization
SME small- and medium-sized entreprise
TNC transnational corporation
UNCED United Nations Conference on Environment and Development
UNEP United Nations Environment Programme
WHO World Health Organization

I. EXECUTIVE SUMMARY

The major sources of pollution and users of natural resources are energy producers, industry, transportation, agriculture and consumers. The present paper concentrates on industry but the issues addressed are profoundly affected by problems beyond its scope, for example, population growth, poverty and disenfranchisement and trade issues.

The basic concept of Ecologically Sustainable Industrial Development (ESID) requires industrial activity to mimic eco-systems in a closed loop where waste becomes a resource for the next link in the loop. Nature teaches that ecological balance is only achieved by a high level of inherent process efficiency and integration between the different organisms or links in the eco-system. Similarly, ESID will be achieved when our processes become inherently efficient and the economic actors "connect" with the next actors in the loop.

Clean technology and cleaner production (CP) - the "hardware" - are the main practical and technical goals to be achieved. Better environmental management, including training and environmental audits, - the "software" - is equally important.

In light of the above, UNIDO and its member governments are urged to:

1. set, as an overall goal, the establishment of cleaner production as the norm by the year 2000 and that ESID (i.e., closed loop with low/zero waste) becomes the norm by the year 2020;

2. cooperate with local and global, governmental and non-governmental institutions and especially with developing countries' governments and with business associations in sharing the task of spreading ESID;

3. promote a fair regulatory framework conducive to ESID and cleaner production which sets precise goals without prescribing the exact methods to reach them, and leaves it to industry to achieve these in the most efficient and economic manner;

4. create incentives for ESID in the marketplace through appropriate taxation and fiscal instruments fostering the internalization of business costs related to resource/energy consumption and pollution;

5. set a good example by requiring all publicly-owned enterprises, public service companies and administrations to uphold the same standards as are demanded from the private sector;

6. ensure that transnational corporations implement the same environmental standards worldwide as in their home markets (given that they are in fact higher);

7. employ focused strategies to solve the environmental problems of Small- and Medium-Sized Enterprises (SMEs) worldwide, including those in the informal sector of developing countries which cannot be reached by traditional means;

8. take advantage of the contacts and know-how of business associations, chambers of commerce, trade unions and special business sectors such as accounting, insurance and banking (banks in particular through their widespread networks can reach otherwise hard-to-reach SMEs);

9. launch an information campaign to show that in many cases even in the short-term, cleaner production and pollution prevention can pay and that they are conditions for the long-term survival and success of a company;

10. promote awareness in business of the need for ESID through education, sensitization and training (e.g., the ICC Business Charter for Sustainable Development). As political, psychological and managerial problems will be harder to solve than the technological ones, motivation through the power of examples and case studies is of highest priority;

11. promote awareness in society and consumers of the need for sustainable development through education, sensitization and training from kindergartens to high schools, technical and business schools to universities;

12. promote the development of R&D relating to cleaner production and ESID by all corporations, and specifically remove hurdles faced by smaller SMEs and individual inventors.

The UNIDO action plan details the above recommendations and should be put into operational terms. UNIDO is urged to:

- take stock of available experience, information and material, matching these with perceived needs and noting discrepancies;

- use, adapt and further develop available material and experience, foster the spread of approaches which have proven themselves, promote the rapid and unbureaucratic distribution of useful information and training and;

- where necessary, help develop information, assessment methods and indicators in those areas where they are most lacking (e.g., focus on developing countries, environmental audits and accounting).

II. BACKGROUND

A. Ecologically sustainable industrial development and the present paper

The present paper has been prepared as a contribution to the UNIDO Conference on Ecologically Sustainable Industrial Development. It describes in practical operational terms some current industrial initiatives for building a special capacity for ESID within each country, mainly by the promotion of cleaner production technology.

This special capacity must deal with both installing new equipment and processes, and operating them; it must also deal with the technical and management problems of cleaner production. While it is clear that the problems relating to the technical side are not all solved, for example, the lack of widely commercially available non-chloro-fluorocarbon-based technologies, there seems to be less of a problem of technology, but more of management. How can industrial managers and workers in older industries be persuaded that clean, or at least cleaner production is viable in their

industry, country and enterprise, and then how can they be helped to achieve it? There are also often political problems which prevent, or at least delay, the introduction of such technologies.

For example, in 1991 a bilateral development agency promoted a new process to recycle toxic chromium salts, traditionally used to tan animal hides into high quality leather goods. The process was adapted for one enterprise at a cost of about US$50,000. It reduced chromium sludge discharges by 99 per cent and produced a return on investment to the enterprise of about 20 per cent per annum after tax. However, other tanning enterprises in that country were reluctant to adopt the new cleaner production technology. It seems that environmental and tax regulations were not rigorously enforced and there were few penalties for toxic discharges; thus enterprise managers were unwilling to risk their limited funds on this new investment. Efforts by the bilateral agency to introduce the proven cleaner production process into similar enterprises in a neighbouring country were rejected because the media had associated the new process with the first country, which was not on good terms with the second country. Strong efforts by the bilateral agency to introduce the proven cleaner production process into a third nearby country were delayed until the agency would finance new local studies to ensure that the process was compatible with the industrial practices of that country. 1/

B. Ecologically sustainable industrial development and clean technology

In 1979, clean technology was defined by the Commission of the European Economic Community as fulfilling three distinct but complementary purposes:

(a) Less pollution discharged into the natural environment (water, air, and earth);

(b) Less waste (low waste and non-waste technology);

(c) Less demand on natural resources (water energy and raw materials).

This definition refers to any technical measures taken to reduce or eliminate at source the production of any nuisance, pollution or waste, and to help save raw materials, and other natural resources. It involves the treatment of pollutants, recycling, retrofitting, energy conservation and installation of equipment that uses air, water or land resources efficiently. In practice, it tends to produce "end-of-pipe" rather than genuine pollution prevention solutions. 2/

In 1991, the new concept of clean technology focuses on optimal products and optimal processes with pollution prevention and resource conservation, and new products that satisfy currently unmet needs. Since technology is a process of constant improvement, the concept of optimal products and processes will be continually redefined. Processes will move towards zero waste/pollution and products will be managed during their whole life cycle from material extraction, manufacturing, use and disposal.

The obstacles to such optimization are at a market level (insufficient incentives), at regulatory level (unenforced standards), at sectoral level (slow growth sectors pollute the most) and at an enterprise level (resistance to change).

C. Cleaner production and the approach of this paper

A more modest objective than ESID is cleaner production, for which industry, together with the agricultural and public-service sectors, can take responsibility. In both developed and developing countries, there is scope for "clean" production as a practical and profitable reality for new, expanding industries; and "cleaner" production as a viable option for older, stable industries. However, the institutional will must be available for governments and financial institutions to create appropriate rewards and penalties for the ESID/CP concept as a better alternative than unrestricted economic industrial development. Cleaner production involves new processes and new products prodded by the internalization of environmental costs as charges in the enterprise.

D. Realities of the competitive industrial world

Business certainly causes extensive pollution in the process of industrial development, but it is sometimes blamed unfairly for environmental pollution and waste of natural resources caused by poverty, population, agriculture, political conflicts or natural disasters. Although some major companies have subcontracted "dirty" production to smaller companies or overseas subsidiaries, there seems to be no limit to the potential for holding business responsible for adverse environmental impact. Responsibility for factory pollution, has expanded to the wider concept of responsibility for raw materials and products.

Thus the competitive industrial world is full of business and environmental uncertainties and determined by hard economic facts. It makes no concession to the industry or enterprises that fail, regardless of their environmental policies. Therefore, despite the ecological rhetoric on environmental issues, industry is more strongly influenced by such factors as cash flow, market share, profit and business survival. Also, most regulated standards for the environment, such as industrial health and safety standards, do not depend upon scientific facts, but more on public beliefs and political or industrial bargaining, very often long-term effects are unknown.

Some countries like Sweden are actually planning for low/zero pollution in selected industries by the year 2000; 3/ and yet, since many energy/mining resources are not renewable, low/zero resource depletion does not seem to be viable. However, as the energy of the sun is for all practical purposes infinite, it is conceivable that future technology could develop new forms of energy and renewable resources, such that these concepts could become viable.

One example of the impossible becoming possible was of a lake in Canada that had been severely polluted by industrial waste. Scientists predicted that rehabilitation in less than a century was unlikely, however, with new technology, the lake became viable again for aquatic life, within 15 years. 4/

E. Special factors in developing countries

In the difficult economic conditions of many developing countries, industry has special problems. The major industrial enterprises in such countries are often nationalized public companies with a record of political rather than economic management, which provide a history of chronic losses. 5/

In some developing countries, both nationalized and private industry often have such worn-out or technologically outdated equipment that they would probably not survive under international competition. With cheap labour, protected markets, little environmental regulation and only limited cash for new investment, short-term survival of the entreprise is more important than dealing with the longer term environmental issues. 6/

Over the last 30 years, many such developing countries have suffered extensive environmental destruction, even from well-meaning industrial development projects, promoted and financed by international agencies, bilateral donors and the international banking community. The objective of such projects has been economic development, for which negative environmental impact has been considered to be an unavoidable side effect. This experience has not contributed to the relationship of mutual trust between developing countries and financial institutions, which is essential for resolving environmental problems. 7/

It is also recognized that prices in international trade with developing countries have been determined without regard to resource maintenance or rehabilitation, resulting in severe loss of bio-diversity and of the natural resource base of some countries.

Environmental pressures and standards are currently much lower in developing countries than in the industrialized world. Transnational corporations have only recently begun to support higher ESID/CP standards wherever they operate. Some developing countries perceive new regulations for cleaner production as disguised trade barriers to protect the market share of Western/Northern industry, to keep third world industry from competing. This perception of mistrust must be recognized when seeking to encourage ESID/CP in developing countries, which do not yet have the necessary institutional capacity or resources, and yet are very alert to possible economic exploitation by industrialized countries.

Case: After many years of pressure from environmentalists, especially in industrialized countries, Brazil, the world's largest developing country debtor (US$ 122 billion), dropped its long-standing opposition to debt-for-nature swaps in June 1991 and planned to convert up to US$ 100 million per year. Debt-for-nature swaps had been previously resisted because they had been viewed as a way in which foreign (i.e. Western) environmental groups might acquire too much influence on the policies concerning the rainforest of Brazil, which until recently had encouraged, rather than prevented, rainforest destruction. 1/

F. Underlying assumptions of experienced industrial managers

Industrial experience has convinced many managers that:

(a) Environment is the responsibility of government, not business;

(b) Some environmental degradation is inevitable in certain types of industrial development, especially in older industries;

(c) Business survival is more directly related to cash flow, market share and profit than to business or environmental ethics;

(d) Environmental protection, like industrial health and safety, is best handled by legislation, regulation and rigorous enforcement, not by appeals to business ethics.

Such attitudes may not survive with the new generation of younger industrial managers of the 1990s for whom ESID may have special value.

III. COSTS AND BENEFITS OF CLEANER PRODUCTION

A. General comments

The ideal industrial system would transform energy and materials into goods, with the highest efficiency in industrial production approaching the limits imposed by the laws of thermodynamics. As much material and energy as possible would be recovered from process wastes and from post-consumer refuse. Such a system would also prevent the release of hazardous substances such as chlorinated hydrocarbons and toxic heavy metals. Although this ideal has yet to be reached, proven technical and managerial approaches can already deliver big gains in the efficiency of industrial production. 8/

Further advances may result from the study of biological systems because many approach this ideal. Whole eco-systems form series of highly efficient closed and interlocking cycles or loops where materials are constantly recycled (e.g. the water cycle, the carbon and nitrogen cycles).

In some new industries, low or zero waste is becoming increasingly viable. In older industries cleaner production may be the only current practical alternative, however, the concept of cleaner production changes rapidly with technological development. Enterprises in the 1990s may achieve levels of cleaner production considered impossible in the 1980s, provided continuing investment is available.

If governments charge full environmental costs to enterprises by means of specific pollution taxes and penalties, and give grants for special cleaner production activities, the costs/grants become "internalized" into enterprise accounting, motivating profitable cleaner production.

Are there limits to cleaner production? Should the enterprise consider its suppliers' and customers' environmental impacts as part of its cleaner production responsibility? Cleaner production is relative, and in many cases, developing countries, even quite advanced ones, may sometimes be prepared to relax their regulations in order to attract major foreign investment. 9/ Do business and government really value cleaner production for itself or for other reasons? A case in point would be the following:

> Case: Business - The chief executive of a petroleum corporation introduced in 1987 the SMART (save money and reduce toxics) programme encouraging ideas from every employee to eliminate waste; by 1991 it had reduced hazardous waste by 60 per cent (compared with 1986) and saved about US$10 million. 10/

B. Costs

Some cleaner production options require little or no new cash investment and are applicable to existing facilities in all enterprises, in both developed and developing countries. They simply involve good production engineering and housekeeping with management and workers taking a new creative interest in resource utilization improvements (reduction of energy, water and materials use); waste stream separation; effective monitoring; pollution prevention; waste recycling and disposal; improved operating routines; and tightening supplier requirements for quality and environmental impacts. Cleaner production can lead to cost savings and a whole range of ideas for improvement in materials, processes, products and pollution, with the know-how adapted to local needs of small- and medium-sized enterprises.

For investment in cleaner production in new facilities, the costs include: costs of cleaner production equipment, possibly higher than that of traditional equipment; all the usual problems in a new technology; lost time in researching availability; installation problems; initial production inefficiencies; unexpected side effects; maintenance and break-down costs; risk that new non-polluting materials may be less effective and more costly; risk that new pollution/resource utilization standards may still not be achieved by the new technology; loss of market share due to production delays; market risk in a possible product change; and risk of market change that could make the new technology irrelevant to new needs.

For investment in cleaner production with older industries, the costs include investment in retrofitting old production facilities for waste reduction and recycling and many of the above problems as well as the possibly serious financial losses from scrapping older plant. For older industry, especially in developing countries with limited cash resources, the higher initial costs of cleaner production may be a poor economic alternative to continuing with the old production system and keeping environmental impacts confidential while avoiding bankruptcy. If other companies' activities survive with "dirty production", pollution prevention may not pay in that case.

Cleaner production can result in a cleaner product which could lead to a market-share advantage, either in local or export markets in which case failure to adopt cleaner production results is an "opportunity loss" i.e. the loss of profits that could have been gained.

C. Benefits

The initial benefit for the enterprise from cleaner production is increased economic return from:

(a) Saving, - direct saving from energy, resources, time etc.;

(b) Profits, - direct benefit from improved competitive products and local/export market share, because greener processes/products give an edge to market competitiveness and meet new environmental standards of customers in many countries;

(c) Saving, - indirect saving from reduced gaseous, liquid and solid wastes, if they can be recycled and sold or result in lower disposal costs; and

(d) Saving, - indirect saving due to reduction of risk from: avoidance of environmental taxes, legal damage suits and pollution penalties, claims and pressures.

Other benefits include:

1. Management, - improved creative management with "openness" as part of corporate environmental policy, with negative impacts are no longer being "secret" but open to facilitate resolution;

2. Resource utilization, - pressures and standards for using air, water and land resources more efficiently, may lead to new cost reductions not envisaged under old production processes;

3. Integrated pollution control, - whereby one pollutant is not converted to another, can also bring risk reduction and improved community relations;

4. Easier compliance, - with stringent national and international environmental standards which increasingly become decided at regional and global political levels;

5. Production efficiency, - in energy economy and better utilization of materials, waste reduction and recycling;

6. Public image, - the advantage of a public corporate profile as "an environmentally responsible company" which strengthens the enterprise's ability to defend itself against environmental pressures;

7. NGOs, - when the enterprise can relate even to aggressive environmental NGOs then there is a general risk reduction, which can ensure its survival in the future;

8. Environmental audit, - can become a management tool rather than a threat; it can ensure that top management is properly informed on environmental activities, results and potential; this could begin with an environmental management audit and proceed to a full annual external environmental audit from the following year;

9. Employment, - enterprises that are environmentally responsible companies find it easier to attract new younger staff and workers of high calibre, many of whom simply will not work for a "dirty" company; 11/

10. Labour relations, - improve when the company health and safety programme in the workplace begins to include the community where the wives and children of the workers live. This demonstrates a "solidarity of common human values" shared by management and workers;

11. Survival, - informed care for the eco-system provides better corporate control on its own survival in the community, region and country; and

12. Market access, - assured access to existing export markets and customers. Some major companies now do "supplier audits" and refuse to use suppliers that fail to practice cleaner production. Again some countries may preclude import of products that do not meet specified cleaner production standards.

D. Selected examples of enterprise initiatives

1. India: Harihar Polyfibers in India, developed a technology to recycle process waste in the synthetic fibre industry and recover hydrochloric acid and caustic soda for re-use, with significant cost savings. The same company also achieved reduced oil consumption with heat control technology which also improved product quality. 12/

2. UK: Blue Circle Cement - introduced the LINKman expert system which monitors the cement kiln to achieve optimal coal utilization and reduces NOx emissions from 500 ppm to 200 ppm. Investment of US$400 million for savings of US$750 million p.a. 13/

3. Brazil: The Companhia Siderurgica Pains steel mill introduced cleaner production with improved rolling mill, water/gas treatment and charcoal handling systems; it was reported that the new systems reduced waste of clean water/air and yet reduced charcoal corsumption, to achieve savings of US$1.5 million per year and avoiding 100(ha. of trees cut per year. 14/

4. Denmark: Haldor Tospoe developed the SNOX process to recover sulphur and nitrogen oxides from power station flue gases, leading to no waste water, slurries or solids and a marketable by-product of sulphuric acid; it took special care to ensure that the technology actually worked in other enterprises/countries; this enabled successful export marketing of SNOX to Holland, Taiwan, Italy and USA. 15/

5. Tanzania: Rehabilitation of its electrostatic precipitators by the Portland Cement Factory was reported to produce a significant reduction of air pollution and to lead to cost savings of about US$8,000 per day. 14/

6. UK: ICI has a new cleaner production policy to reduce its waste generation by 50 per cent by 1995 with investment of about US$300 million per annum which is about 20 per cent of the capital budget. The plan is threatened by the need to improve short-term earnings. 16/

7. Zambia: The Chilanga Cement Co. installed two dust cyclone arresters and filters between its kiln and chimneys which resulted in a cleaner working environment (less dust emitted), higher productivity, less welfare expenses, less corrosion of equipment and net savings of US$40,000 per year. 16/

8. USA/USSR: The Princeton Moscow Trading Corp. has made an agreement with the City of Moscow to collect and shred used tires in the US, ship them to the Soviet Union and use the recycled rubber in road resurfacing. This process which has already been used in Newark, NJ is a good example of "waste" being turned into a useful "resource" elsewhere. 17/

9. France: Renault and Peugeot, France's two large vehicle manufacturers, have separately teamed up with several specialized recycling companies to recycle metals, plastics, tires, oils, other car fluids, batteries and other components of cars. They started early in 1991 two-year pilot-projects and if successful intend to extend this programme to completely recycle all their turned-in cars by the year 2000. 18/

E. Opportunities for building a special cleaner production capacity

Taking advantage of cleaner production in creating environmentally efficient production processes involves: improved production engineering and housekeeping; substituting toxic production process materials; changing manufacturing processes; recovering materials, water and energy from waste streams for re-use or re-sale to other enterprises; identifying process opportunities with such management tools as: environmental audit, monitoring, worker incentive schemes, and even allocation of full environmental waste treatment/disposal costs to production units, to motivate cost savings.

To take advantage of cleaner production in creating new product opportunities, companies need a new product capability to minimize environmental impacts at each stage of the life cycle, and yet to ensure adequate product quality. This involves: research into new product needs; willingness to replace existing products; new ways for product renewal and repair; new product design for reduced material content and increased recycling potential; new responsibility for product materials, process, use and disposal; and new forms of cooperation with customers, competitors, suppliers, governments and NGOs.

The cost and benefits of cleaner production depend upon the industrial sector, country and enterprise. Cleaner production is usually easier and more profitable for newer expanding industries. Older stable, neglected, "dirty", unprofitable enterprises, which exist in many countries, have harder cleaner production decisions to make if they are to survive increasingly severe environmental regulations.

For small- and medium-sized enterprises in developing countries, it has been found that improved "production engineering housekeeping" can have a significant cleaner production effect without major investment.

In a highly competitive environment, perhaps Annual External Environmental Audits for all major companies is the best way for cleaner production problems and potential solutions, to come to the attention of top management. However, up to 1991, relatively few companies had actually implemented effective overall cleaner production, pollution prevention and waste minimization programmes, let alone strategies for the new concept of "optimal products and processes" for ESID. Thus the current opportunities for cleaner production improvement are almost unlimited, in both developed and developing countries. An example of a total approach would be the following:

> Case: Ernst Winter & Sohn developed and adopted an integrated system of environmental business management for the whole organization at every level. Many of the cleaner production opportunities developed in the company, seemed applicable to enterprises in both newer and older, larger and smaller industries. The EEC therefore helped to finance a book to illustrate the system with text and comprehensive practical checklists: "Business and the Environment". 19/

IV. ROLE OF FINANCIAL INSTITUTIONS

A. General comments

Investment in new technology and equipment can generally lead to cleaner production, thus the availability of investment financing can be critical. Commercial banks and financial institutions have taken little interest in cleaner production or the environmental impact of the projects they finance, because they have not been major financial risks. The important negative environmental impact of older environmentally degrading companies may perhaps be linked to their lack of credit-worthiness.

With increasing political environmental pressures, the risk of financial failures due to environmental causes is much higher than ever before. However, until a pollution disaster arises, business (and finance houses) still tend to concentrate on the risks from competitive national and international markets.

Major banks and financial institutions have begun to recognize a need for the "green image" of an environmentally responsible company to attract young staff of high calibre. They are taking more interest in environmental compliance, and in measuring environmental risk. Environmental Impact Assessment is an established regulatory tool for assessing the environmental impacts of new major projects, but it has been often criticized for poor quality and it lacks "follow up" mechanisms for assessing the subsequent environmental and financial risk of the project during operation.

Although annual financial audit of major clients is required, the finance houses wonder if they "dare" ask clients for annual external environmental audit which would alert them to new major financial risks. However future EEC directives on Environmental Impact Assessment may soon make annual external environmental audit as normal as financial audit, and will bring benefits both to lenders and borrowers.

B. Commercial and merchant banks

The usual criteria for commercial bank lending relate to: purpose, personal relationship of trust, profitability and payback. The major risk is business failure, which can be provoked by environmental issues, e.g., "secure" land values can be suddenly diminished by pollution.

Increasing environmental regulation, public and NGO pressures on all parties involved in projects that have negative environmental impacts, has forced banks to begin to consider the "green" aspects of new project financing. Thus the image of the bank makes it reluctant to finance heavily polluting projects without some effort towards cleaner production. A case in point:

> Case: In 1989/91 in the EEC, major banks provided financial support for two major geographical projects: one for a car testing area and one for nuclear waste reprocessing; both had completed Environmental Impact Assessments and all the legal steps and obtained official approval. However after considerable investment of funds, they were stopped by political pressures (the NIMBY syndrome: not in my back yard) from environmental protest groups. This resulted in severe financial losses for the companies and increased risk for the banks. 1/

Some banks in the EEC are beginning to recognize the risk and to offer a range of environmental services to their customers including: environmental data banks, advice, training etc., thus reducing risk from environmental factors. 20/

C. National development banks and financing bodies

Government-sponsored development banks and other funding bodies already have employment, social and political objectives in financing industrial development projects. They could finance ESID and CP special projects which cannot meet the criteria for commercial bank lending. Such development banks are beginning to employ professional environmental management staff who are able to give advice on cleaner production projects and influence borrowers to give more thought to these issues.

D. International development banks

Until well into the 1980s, the international development banks (World Bank, African Development Bank, Inter-American Development Bank and Asia Development Bank) gave little attention to the environmental impacts of their activities. They employed mostly economists and accountants with only a handful of environmental specialists; thus economic industrial development was the key lending criteria.

However many projects brought such unexpected severe pollution and uneconomic use of environmental resources that now they seriously screen future investment projects for environmental risk and encourage ESID and CP. They have expanded their professional environmental staff extensively, which indicates a change of real priorities. Newer institutions, such as the London-based European Bank for Reconstruction and Development (see example below) are taking environmental concerns into account from the very beginning.

> Case: The World Bank started in November 1990 the Global Environmental Facility with financial commitments of $1.5 billion over 3 years (representing 2 per cent of total commitments) to spend on programmes which positively affect global environmental quality. This year's programme focuses on bio-diversity. The first working meeting in May 1991 allotted US$214 million for 15 environmental projects and another US$59 million for technical support. UNDP plays a key role in identifying potential projects and local NGOs are envisaged to benefit from project financing. 21/

E. Special environmental financial institutions

Several special institutions exist which directly or indirectly finance environmental projects which may not meet the criteria for commercial lending. These include the EEC COMETT programme, which funds a range of industrial research and environmental pilot projects, and the Budapest Regional Environmental Center, which supports the activities of environmental NGOs in Eastern Europe through financial, logistical and technical assistance.

F. Selected financial initiatives

1. Indonesia: The State Minister of Environment and Finance urged bankers to support the governments AMDAL (ESID/CP) policies, because 75 per cent of the funds used to develop industry were provided by the banks. One major bank responded by assigning a senior officer to introduce environmental conditions as part of major bank lending agreements; however they reported that it was difficult to follow compliance, due to lack of environmental law enforcement. 22/

2. International: The World Bank approved US$340 million financing for Poland to improve the efficiency of bulk-heat supply to domestic and industrial users and exploit natural gas resources instead of coal. The World Bank policy on financing waste management projects in developing countries is shifting away from technological issues towards an evaluation of the policy framework needed for successful resource recovery systems. This clearly recognizes that for cleaner production, management is a far more important problem than technology. The World Bank's 1992 World Economic Report will focus on environmental issues. 21/

3. USA: Bankamerica Corporation is the first U.S. bank to adopt a set of environmental principles in January 1991 including a special effort to find and support enterprises that are seeking cleaner production. The bank created a unit of Environmental Policies and Programmes and established a senior management team to monitor progress. 23/

4. France: Since 1990, the Banque Populaire du Haut-Rhin finances at preferential rates cleaner production projects for SMEs which are previously professionally evaluated by an eco-counselor as to their effects on air, water and solid waste. 24/

5. India: the World Bank's first Asian loan devoted exclusively to environmental protection was made in 1991. The US$124 million loan and an additional credit of US$31.6 million will finance a programme designed to reduce chemical pollution from older plants in the dye, fertilizers, pharmaceuticals, pesticides and petrochemical industries. The programme includes strengthening the capacity of monitoring agencies and building waste-treatment facilities in industrial parks for SMEs. 1/

6. International: The European Bank for Reconstruction and Development's first loan to former centrally planned economy country (June 1991) was a US$50 million loan to the former regional branch of the Polish National Bank in Poznan. This loan will be used by municipalities and enterprises in 10 cities to improve energy efficiency and reduce dependence on high-sulfur coal by replacing coal-fired boilers by gas-fired boilers. 25/

G. Opportunities for building a special cleaner production capacity

The role of financial institutions can go beyond helping environmentally responsible companies into creating the financial environment that promotes cleaner production. They could provide the full range of environmental services (data banks, advice, audit, training seminars), develop a range of environmental educational publications and encourage cleaner production by preferential lending arrangements.

Financial institutions, especially private ones, should be more aggressive in promoting innovations and the capacity of small businesses to expand if their processes are more environmentally benign.

Financial institutions could, in partnership with development agencies, jointly fund ESID and CP projects (50 per cent grant, 50 per cent loan) in developing countries; this would bring the discipline of commercial financing to development projects and it could particularly sponsor the rehabilitation of older industries, or even its restructuring along environmentally friendlier lines, i.e., help it to undergo "eco-restructuring."

In the longer term, they could use "debt-for-nature swaps" to provide national development banks with financial resources to finance ESID/CP projects by buying up discounted debt instruments on the market and returning them to the issuing country to allow local financing of environmental projects.

They could encourage client companies to adopt both a financial audit and a simple annual external environmental audit as useful management tools for the management of ESID/CP.

Finally, in their long-term interest, these institutions should encourage environmental management education in universities, technical colleges and business schools by funding and other appropriate assistance.

V. CONSTRAINTS FOR SMALL- AND MEDIUM-SIZED ENTERPRISES

A. General comments

SMEs can be confronted by different problems depending on their location (developed or developing country), their activity (industry, retail, services) their size, (small, medium or artisans), age, legal status, capitalization, management structure (owner-manager, employed manager) and ownership structure (individual or corporate/institutional ownership).

It is often forgotten that in many countries SMEs as a whole carry more economic weight than large companies whether in terms of employment or production. SMEs employ more people and consistently create more new jobs, train more young employees, produce and innovate more. From a historical point of view, SMEs form the economic tissue and in some countries (e.g. Germany) have been the backbone of the economy. Most of today's large companies started out as small-scale ones.

The particular problems of SMEs are often overlooked. This is often because SMEs are not well enough represented in economic fora. Their owners very often manage the enterprise and they cannot absent themselves from their business and have no time to defend their interests at the local, national or international level.

SMEs in developing countries are confronted with all the problems faced by their counterparts elsewhere with the added difficulties inherent to the fact that many of them belong to the informal sector. The high transactions costs associated with the regular economy, often the consequence of large but inefficient bureaucracies and cumbersome procedures, and a lack of training in fundamental business concepts hinder the full integration of SMEs into official markets. This leads to a loss of governmental overview and control. Once again, the problems are ones better solved through education of national and local authorities so that the conditions are created to unleash the creative power of individual initiative through SMEs.

Case. The city of Cairo (10 million inhabitants) after failing to introduce a Western-style garbage collection system because of infrastructure and financial problems, belatedly decided in 1990 to help the traditionally despised Zabbaleen to modernize their operations. The Zabbaleen are Cairo's more than 50,000-strong traditional garbage collectors and recyclers belonging to the informal sector. More than a dozen new Zabbaleen SMEs now operate commercially. 26/ This successful example of the reintegration of people and de facto SMEs previously belonging to the informal sector and of providing a highly efficient and flexible service deserves to be imitated.

SMEs are in many cases family enterprises where the owners wish that their children one day take over the business. Their long-term thinking makes them often more receptive to a business policy which protects the environment for the benefit of future generations. By contrast, professional managers of large companies are tempted to give highest priority to the maximization of short-term profits to ensure the renewal of their contract.

SMEs are also often "one person shows" where the owner manages everything including environmental issues. This explains why in many SMEs, the owners, in spite of great efforts, can do much less for the environment than they would wish. SMEs may know that they pollute "just a little" (or a lot) but because there are so many, they may collectively do severe environmental damage which is tolerated because the community needs employment. Cases have arisen in the EEC where a few small pulp/paper factories created a pollution problem for a whole region; and similarly where one SME waste oil spillage polluted the drinking water supply for a city. So even single SMEs may at times cause as much environmental damage as major industrial enterprises.

Many SMEs are recent enterprises (specializing in high technology) which are dynamic, innovative and competitive in national and export markets. They can react much faster than larger companies to both market and cleaner production opportunities; but their critical constraint is shortage of finance which is often a function of their successful rapid expansion. In fact, it was SMEs such as these which, by their pilot projects, gave the decisive push for the present environmental management movement.

But the vast majority is still dependent on old technology; they have the risk of short-term failure, and thus long-term planning is often irrelevant. They have no great political power to defend themselves from environmental pressures so they prefer to avoid public attention.

Some SME enterprise managers may not even see the cleaner production problem. Even in Germany - where environmental issues have become deeply ingrained - 30 per cent of managers are not familiar with the environmental regulations that they are supposed to comply with. 27/ For them environmental concern leads to costs with no benefits; and thus their strategy is minimal compliance with the legal health, welfare and environmental standards. Managers in these enterprises often feel that cleaner production investment is not economic or viable for their limited operations and that the pollution they create is too small to be of significance.

Strict enforcement of even existing environmental standards could well force many enterprises into bankruptcy; thus non-enforcement is a must to them. Fortunately for them, there is less pressure from the press, and NGOs on such small enterprises.

For their possible cleaner production projects, such enterprises may well have too little access to adequate investment capital, adequate patent rights, protected markets, international sources of information and materials etc. This may well make potential cleaner production investment too difficult and uneconomic for serious consideration.

B. Selected examples of initiatives of small- and medium-sized enterprises

Examples that can be presented to illustrate the success of individual SMEs in both developing countries and in European transitional economies include the following:

1. India: Confrontation with higher energy costs has motivated hundreds of SMEs to use the technology of anaerobic digestion of sugar cane waste, to produce methane for their local energy needs. 28/

2. Botswana: With difficulty in material supply, UNIDO assisted an SME to develop a small-scale labour-intensive plant to produce moulded fibre newsprint from recycled newspaper and agro-waste which had previously caused severe pollution.

3. China: UNIDO, with Belgian support, assisted Xing Guand Plastics Recycling Factory to develop a complete pilot unit for recycling of plastic wastes. The unit will enable it to use 40 per cent recycled raw materials.

4. Zambia: Ndola Lime Works introduced two rotary kilns and technology changes in lime making, which led to improved output and efficiency, lower costs, cleaner working areas, fewer accidents and resulted in savings of US$52,630. 29/

5. Holland: Sericol introduced a process to use water-based printing ink, comparable with existing solvent-based ink, leading to high speed radio-frequency drying and complete elimination of solvent waste and pollution. 30/

6. Zambia: By installing dust collecting equipment and using treated effluents to wash and soak hides, the Asaria Leather tanning company ended up with a cleaner process, a cleaner work environment, was less harassed by neighbors and saves US$28,000 a year. 14/

7. Madagascar: Brick manufacturers in Antsokay-Toliaba substituted firewood, previously obtained in the Southern part of Madagascar where forests are sparse and constituted of rare species, by mineral coal. The new method of spread-out combustible charge saves US$78,000 per year and preserves South Madagascar's environment. 14/

8. India: A textile mill in Bombay increased the collection rate of the caustic soda from its mercerizing wash waters from 75 per cent to 85 per cent and the recovery rate from 81 per cent to 90 per cent by more efficient washing, better filtration, correcting leakage and seepage and other corrective measures. Net savings of 415 kg of caustic soda per day led to expected savings of 684,750 Rupees/year. 12/

C. Opportunities for building a special cleaner production capacity

Low cost cleaner production with good production engineering and housekeeping is viable for most of these enterprises. For SMEs in developing countries, whose critical concern is often short-term survival, and which have little need to comply with environmental regulations, the motivation for cleaner production may be more difficult to stimulate.

With new industry and technology and international market competitiveness, cleaner production can offer advantage to some aggressive small- and medium-sized enterprises, which might well create "role models of cleaner production" for others to follow. Pilot projects for cleaner production could be set up in different industries to motivate other SMEs. They will only be credible if they are successful and followed by profitable companies well-known and respected in the industry.

Since the key problem in cleaner production is management rather than technology, development agencies need better knowledge of SME problems and more direct relations with SMEs. They need a deeper understanding of SME problems in different regions and industries, because there are no universal cleaner production solutions.

VI. ROLE OF TRANSNATIONAL CORPORATIONS

A. General comments

Transnational corporations (TNCs) can and do make a major contribution to cleaner production. Being considered as environmentally responsible companies is vital for the continued success of such major enterprises, as they are under public scrutiny by the media and NGOs. However, they have the financial resources, and often the political power to defend themselves and, most importantly, to gain time in meeting new environmental standards.

Many TNCs have formally accepted the various environmental guidelines developed by EC, UNCTC, OECD, ICC and the CMA's CARE programme. They also are pioneers in integrating environmental concerns in quality assurance systems, i.e., in a Total Quality Management system. However they still resist annual external environmental audit which would professionally certify their compliance. In industrialized countries trade unions are slowly becoming environmental pressure groups to force TNCs into annual external environmental audit. 30/

Most TNCs have current data on their environmental impacts through sophisticated internal Environmental Management Audits, but with some exceptions they usually keep the results very confidential. 31/ However they receive the continued attention of the international news media and NGOs, and they are motivated over time towards cleaner production if only to reduce these pressures.

In the past some corporations, prodded by the NIMBY (not in my back yard) phenomenon, helped to export "dirty" technology to developing countries where it could still be used without constraints. 4/ Furthermore, in the past, some major enterprises sub-contracted "unacceptable" processes and products, to overseas SMEs which escape public attention and criticism. This is becoming increasingly less acceptable to the public which is demanding that international TNCs apply, as a minimum, environmental standards set up in their home countries, wherever they operate.

B. Selected transnational initiatives

1. Union Carbide - after the Bhopal disaster the corporation became a model environmentally responsible company with comprehensive environmental policies, high-level management responsibility, increased environmental staff and resources, audits etc. 1/

2. Monsanto established in 1988, a goal to reduce toxic air emissions by 90 per cent by 1993 and has stated its goal for itself, its contractors and suppliers and shippers as "Zero spills. Zero releases. Zero incidents. Zero excuses!!" 32/

3. ICI, Union Carbide, Kodak and DuPont - are among many firms that now tie a portion of their managers' compensation to their environmental performance. Dupont - has a policy to retrain every year every employee (including the Chairman) on cleaner production issues. 1/

4. Aracruz Cellulose - Brazil's largest paper and pulp producer applies the high Swedish standards. 1/

5. Ford - requires all local suppliers in developing countries to improve both industrial product quality and processes. Through its procurement policies, it is a major influence for cleaner production on its suppliers. 1/

6. Reynolds Metal - pioneered aluminum recycling by buying beverage cans and other products from consumers. By 1991, it had recycled four billion pounds of aluminum. 33/

7. ICI - has increased up to seven times the internal charges for dumping chemical wastes from its biggest manufacturing site, to put pressure on managers to reduce waste from production operations. 31/

8. Procter & Gamble - sub-contracts its waste disposal but audits each contractor annually to ensure that no negative environmental impacts reflect badly on its image; the "opportunity" cost of such impacts is relevant. 1/

9. Waste Management Inc. - has formed cooperative recycling ventures with Du Pont, (plastics), American National Can (metal), Stone Container (paper containers), Smurfit Paper (newsprint) to combine talents, reduce risks and link supply and demand in the recycling area. 34/

10. Del Monte's pineapple plant in the Philippines sells its pineapple waste for use as cattle feed for US$50,000 a year, thereby also avoiding more than US$55,000 a year in hauling costs for a total benefit of more than US$ 105,000 per year. 14/

11. Otto Versand, one of the world's largest mail-order companies, had its German catalog products and operations in Hamburg environmentally checked by the consumer/environmental organisation AUGE and banned many products which did not meet its standards. 35/

12. Norsk Hydro UK, the British affiliate of Norway's largest chemical, oil, fertilizer and light metals group, audited all its operations in 1990 for environmental performance and had its internal assessment externally audited by Lloyds Register and published. The corporate parent includes a comprehensive environmental report in its annual report as now do most large chemical companies. 36/

13. Bayer AG, one of the three German chemical conglomerates, is doing research on biological pest control and genetically engineered plants more resistant to diseases etc. to reduce its dependence on its herbicide and pesticides product line and anticipate growing demand for less harmful plant protection products. 1/

C. Opportunities for building a special cleaner production capacity

The International Chamber of Commerce (ICC) in Paris formulated the "Business Charter for Sustainable Development" which supports the goals of cleaner production and ESID with a strong emphasis on management commitment. Prepared in cooperation with the German Environmental Management Association (BAUM) and the Global Environmental Management Initiative (GEMI), the Charter was officially launched at the Second World Industry Conference on Environmental Management (WICEM II) in 1991. It has been adopted by many transnational corporations as the standard code of behaviour for transnational environmental policies and operations throughout the world.

It has also been endorsed by many international organisations (including UNIDO and UNEP) and signed by hundreds of companies and industrial associations throughout the world. Further commitment to and, above all, implementation of the Business Charter worldwide will show how serious industry is about cleaner production.

The Business Council for Sustainable Development set up to advise the UNCED Secretariat on business issues - with the support of 50 international business leaders - is conducting research on many aspects of sustainable development, including "optimal processes and products" for transnationals as role models for ESID.

Now that transnational corporations set global environmental policies and standards for themselves, they should stimulate promotion and transfer of ecologically sound practices and production to their industry and suppliers in developing countries and help educate SMEs in the intricacies of total quality management. They have the cash resources, standards, management experience and the R&D capacity to do so. They also wield immense political influence in certain developing countries which could be used to promote, rather than hinder, fair legislation and regulatory enforcement for cleaner production and ESID.

To prevent a backlash from indigenous industry which might condemn what it perceives as attempts to impose standards only TNCs can reach, TNCs should make gestures of goodwill by offering to share non-competitive expertise (e.g., on total quality management systems) and contribute to "openness" on environmental issues by requiring their international subsidiaries to make public the summary reports on their internal Environmental Management Audits.

The motivations are usually to provide for long-term survival and security, deter increased government regulation, take advantage of environmental "tax-breaks", reduce the risk of massive legal damage claims on

the holding company for damage done by subsidiaries (such as was the case after the Bhopal accident); and to demonstrate that good long-term business implies environmentalist business management with cleaner production.

The interest of transnationals in cleaner production has not come about by simple benevolent concern; it has been profoundly influenced by the major malpractice and disasters in recent years which have resulted in claims against them for millions and sometimes billions of dollars. Perhaps this experience will provide strong economic motives to ensure that the public demands for ESID and cleaner production will be realized.

TNCs can use their powerful economic and political resources to seek in the longer-term environmentally optimal products and processes while in the shorter-term, promote new attitudes towards ESID and cleaner production in the difficult economic conditions of many developing countries.

VII. NEED FOR HUMAN RESOURCE DEVELOPMENT

A. General comments

UN experience has shown that training is the critical success factor in every technology transfer project. For managers and workers at every level, this training involves not merely new knowledge, but new practical skills and perhaps new attitudes.

In introducing new standards for health and safety of workers, WHO/ILO experience has shown that it may take generations of industrial managers to overcome a tradition of minimal concern. Similarly, in introducing new standards of cleaner production, many experienced industrial managers may well be reluctant to make changes in proven technology and proven organization, to introduce cleaner production.

Thus, there is a need for specific human resource development within each enterprise when introducing cleaner production into an industry or target group. However the precise training needs may be different for each country, industry and enterprise. This is especially significant in developing countries, where there may be no environmental training in schools, technical colleges and universities.

Even recently, major business schools did not cover environmental issues in their programmes; they regarded them as a low priority, compared with finance, marketing, organization, management information systems, technology management etc. Even courses in the management of technology included little data on cleaner production.

Company training should include ESID and CP concepts, not only as special courses, but as part of the established management development programmes as all functions have an impact on the management of cleaner production.

Some training for industrial managers in environmental management audit and annual external environmental audit would contribute to cleaner production, as well as to the efficiency and effectiveness of such audits, which are becoming critical management tools. Managers could receive special experience as members of an audit team of another unit or company; it would stimulate new ideas for cleaner production and perhaps also contribute to "openness" rather than secrecy about environmental problems.

Industrial associations can perhaps coordinate resources for development of training materials and packages for use by their members and also, where appropriate, for developing countries.

B. Selected examples of human resource initiatives

The following are examples of successful initiatives in the human resources area:

1. Packages - ILO/UNEP developed an environmental management and cleaner production series of five-volumes for developing countries. A supporting text book will be available in 1991. 37/

2. Project Copernicus - has been set up by the Conference of European Rectors, to introduce environmental training into 400 schools, universities and technical training colleges throughout the EEC. 38/

3. BAUM - In Germany, BAUM (the German Environmental Management Association, member of INEM, the International Network for Environmental Management) approaches human resources development for cleaner production by involving workers, supervisors and managers in the training process for environmental concern. Its philosophy is to make the company "environmentally intelligent" by involving the Human Resources department and the Worker's Council in the realization of the company's environmental strategies. 39/

4.UN - Industry cooperates with UNIDO, UNEP/IEO, ILO and other UN bodies for training programmes for CP and ESID in many developing countries.

5. Eco-Conseil - Industrial companies and local authorities in France are supporting the training institute Eco-Conseil in Strasbourg which trains environmental advisers mainly for municipal authorities. The demand for these environmental counsellors outstrips the supply. 1/

6. Business Schools - The European Business School at Schloss Reichartshausen (Rheingau, Germany) set up, in 1987, a chair for environmental management. In 1990/91, two other major international business schools (International Institute for Management Development in Switzerland and the European Institute of Business Administration in France) set up chairs for environmental management, financed by major corporations which have a special interest in ESID and CP. Thus environment will (slowly) begin to be a part of all future MBA and executive programmes. 1/

7. Materials - Shell International makes its environmental training materials available to any enterprise seeking training assistance. 1/

8. Students - AIESEC, the world's largest student organisation - including 40,000 business students in 170 countries - devotes, since 1989, many of its conferences and publications to the interplay of environmental issues and their impact on business practices. 1/

C. Opportunities for building a special cleaner production capacity

In developing countries all industrial development projects financed by banks or development agencies need a component for cleaner production training. Such training for managers and workers can often be done with local institutes, business schools etc. to stimulate a value system for practical cleaner production in the country. To ensure that the values of managers, their families, acquaintances and society in general reflect the tenets of ESID, it is important to find creative ways to foster the underlying principles of sustainable development, for example by using locally popular mass media.

Training initiatives in cleaner production are only just beginning to grow in volume and popularity. Some companies are reluctant to share new training materials on cleaner production with other companies because of confidentiality and high investment cost. Yet, most companies share CP/ESID materials freely as a service to their industry.

Much management training is often rather ineffective in inducing change. After the course, there is no research on practical "outcomes". In addition to the normal criteria used to evaluate, there should be - three, six or 12 months after the training ended - feedback whether it actually made a difference in operations.

Many organizations are producing cleaner production training materials including: UNIDO, ILO, UNEP/IEO, ICC, BAUM, US EPA etc. which are available for use in developed and developing countries. How efficient ("doing things right") and how effective ("doing the right things") current training activities and materials are - especially in developing countries - remains to be researched.

VIII. RELATIONSHIPS OF INDUSTRY WITH GOVERNMENT AND PUBLIC INSTITUTIONS

A. General comments

Industry and government have a common objective in seeking industrial development for economic growth and employment for labour. However, industry and government often have conflicts on the standards and timing of regulations for environmental protection.

In countries where large sectors of industry are run by nationalized public companies, government policies for ESID/CP are often not supported by private industry. This is because for decades such public enterprises may have been managed with other objectives than for industrial efficiency or return on investment alone. This is often the case in Africa and was also true of centrally planned economies. 5/ Thus government policies for ESID/CP will only be taken seriously by private industry when governments can actually demonstrate cleaner production in their own public companies, railways, post office, military and other public services.

The government-industry relationship expressed through employers' organizations, industrial associations, and chambers of commerce has, since 1989, become receptive to the concept of more demanding cleaner production i.e. waste prevention, especially for new industries where new investment is concerned. However with old industries, the government is more tolerant of negative environmental impacts and encourages less demanding cleaner production i.e. waste recycling and pollution reduction to "acceptable levels".

With increasing political pressures for environmental concern in the European Community, industry concentrates on providing advice on legislation and time horizons that are "realistic" and yet allow to move towards the standards of EEC directives.

Negotiations on a particular pollutant material sometimes (but not always) seem to follow a curious life cycle: environmental impact, industrial denial, further research, industrial agreement on the danger but no acceptance because of inability to change, lack of viable substitutes, danger of destruction of the industry, loss of employment. This is followed by further research and international evidence that alternatives are viable, finally by industrial acceptance of a distant time horizon, followed by some industry members rapidly developing, using and marketing alternative materials, and last by general industry acceptance and compliance. The critical skill of the businessman is to survive - by continually adapting to those pressures.

B. Selected examples of government and public institution initiatives

As the following examples illustrate, the industry-government nexus in the promotion of ESID is both complex and multi-faceted:

1. The India National Steel Company adopted ESID/CP policies for all of its plants and plans to become a "role model" for ESID/CP, meeting international standards. Thus the Government is demonstrating ESID/CP to show that its policies should be taken seriously. 1/

2. Government and Industry cooperate in the UK, to provide a whole range of training publications, videos, data banks, newsletters and information services on various aspects of ESID/CP for use by enterprises. 40/

3. The EEC created in early 1989 the Network for Environmental Technology Transfer (NETT) which centralizes legal and technical environmental information in a database. NETT now offers a wider range of services including personalized help, conference organization etc. 41/

4. Government and Industry in the EEC cooperate in negotiating reduction of volatile organic compounds which affect the oil, car, manufacturing, printing and metal product sectors, and in present and future eco-labeling systems studies that deal with the problems of setting criteria for eco-label awards. 42/

5. The ILO worked in Indonesia to help APINDO (the Employers' Association) provide an environmental information service with training and audit capacity and maybe create a BAUM-type association. The project is currently deferred while awaiting further funding. 22/

6. The Spanish Postal Service has opened its network of over 13,000 branches for the collection of small (non-automotive) consumer batteries. These will then be recycled by private companies to recover the cadmium and mercury. 17/

C. Opportunities for building a special cleaner production capacity

Government can demonstrate ESID/CP in the nationalised public industries and public services, to provide the "role model" to motivate private industry to follow and make ESID/CP an accepted part of its strategic planning. Similarly, Government failure to set an example de-motivates private industry.

As Government cooperates with industry, for the design of "Polluter Pays Principle" legislation for taxation and provides grants for ESID/CP, this will effect a net transfer of funds from polluting to non-polluting enterprises and thus make ESID/CP investment economically more viable for the enterprise.

Some governments are moving towards annual external environmental audits with published results, as a useful tool for both government and industry to motivate ESID/CP.

To encourage enterprises to use annual external environmental audits, it is important that public reporting of the auditing should follow the procedures of financial audit reporting, i.e. a professional certificate that standards are met "in all material respects" but not a massive disclosure of confidential production, cost and profit data.

IX. ROLE OF NATIONAL INDUSTRIAL FEDERATIONS, CHAMBERS OF COMMERCE, TRADE UNIONS AND NGOs

A. General comments

The role of these organizations is critical as a channel of industry cooperation with the government on creating the "industrial motivators" for ESID/CP. Such organizations which are often defensive on environmental issues, can slowly be influenced by the volume of new research and data on ESID/CP which is demonstrating its feasibility and viability throughout the world. This has encouraged some industrial associations to set up data banks on ESID/CP potential for the use of members.

In some countries, trade unions have a strong motivational and creative role to play in cleaner production. Just as their influence in health and safety has contributed to a revolution in the workplace, so they have begun to recognize the role of the environment for health and safety in the community, and begin to encourage ESID/CP. It needs to be pointed out that ESID will probably be a net creator of jobs as many ESID goals may require techniques (such as disassembling for reuse) which are more labour intensive than capital intensive.

Case: The Paper and Forestry Workers' Federation (Québec, Canada) welcomed the recent decision by the Québec government to replace previous chemical-intensive deforestation methods (spraying by plane requires little personnel) by mechanical methods which would create many new jobs (chain saw operators) and be less damaging to the forest as a whole. 14/

Many trade unions recognize the need to inform the work force about the longer-term values of ESID/CP. However, in many developing countries, the unions are increasingly marginalised, so that ESID and CP are often low priorities. Trade unions are slowly beginning to recognize the "third man concept" i.e., negotiations for wages involve management, labour and environment. The costs of the "third man" (environment) require some sacrifices by the other two parties for the common good. This is the cost of enterprise survival and continuity of worker employment.

Environmental NGOs have a usefully provocative role to play in ESID/CP. Some NGOs currently have professional environmental staff and a high technical research capacity, which can challenge industrial scientific data; perhaps this is another justification for annual external environmental audit whereby an NGO can be member of the audit team.

Chambers of Commerce are often the closest to SMEs and local industry; thus they can be active in CP and ESID training programmes in ways that have specific local significance and impact. Chambers of Commerce in Germany (over 70 per cent have environmental programmes e.g., in Nürnberg, Hamburg etc.), Holland (Gelderland) and France (Avignon and Colmar) are pioneers in this area.

Numerous other organizations are active in promoting various aspects of ESID/CP including: INEM, ICC, ISO, BCSD, British Quality Association etc. The UN system (UNEP, UNIDO, UNESCO, ILO, WHO/IPCS) is very active, directly or indirectly, in ESID/CP with projects, newsletters, publications, industrial working groups, training programmes, congresses, data banks etc.

B. Selected examples of initiatives of these organizations

1. The Canadian Chemical Manufacturers' Association started its "Responsible Care Programme" for its members and large chemical associations worldwide (USA, Europe, Japan) have since adopted versions of Responsible Care. The programme sets out an environmentally responsible code of required conduct, with supporting information, training activities and reporting requirements. 43/

2. ILO devoted its entire 1990 Annual Report to environmental issues, with clear support for ESID/CP. 22/

3. An NGO in Ecuador reported on new heavy pollution impacts by industrial companies with their own TV camera news team. The report appeared that same night on national TV and was a strong motivator for remedial action and policies of ESID/CP. 44/

4. Industrial enterprises are beginning to collaborate with Greenpeace to resolve their pollution problems; Greenpeace has its own professional technical capacity and is thus fully qualified to help. 45/

5. In the United Kingdom, the Institute of Waste Management in cooperation with the Department of Trade and Industry, has developed "quality standards" for waste transport, disposal and dump management which are being slowly adopted by members of the industry. 46/

6. The International Chamber of Commerce developed Environmental Guidelines for World Industry and recently completed them with more specific Guidelines for Solid Wastes as well as Environmental Auditing. They recommend that the Guidelines for Environmental Auditing be used as an internal management tool, leaving to individual companies the choice of publicizing results or not. 47/

7. The UK Chemical Industries Association (CIA) encouraged its members to take a more open and consistent view to disclosure of information to Friends of the Earth. Dow and Monsanto are for full disclosure, but ICI, Shell, Du Pont and Albright Wilson are undecided. 48/

8. The Association of European Automobile Constructors is proposing a European network of licensed car centers, to improve existing arrangements for vehicle dismantling and recycling. 31/

9. Some Chambers of Commerce have introduced a simple system for annual external environmental audit which awards each enterprise positively rated with an environmentally responsible company certificate, and can give local community recognition for enterprise ESID/CP achievements. This is designed to encourage local SMEs to conform to local standards of measured progress towards ESID/CP.

10. The Canadian federal and provincial Round Tables for the Environment and the Economy bring together representatives of industry, government and NGOs to find common solutions to environmental problems. They then make recommendations to government at a regional and national level. 49/

11. The Industry Consortium for Ozone Layer Protection is a group of leading US, European and Japanese corporations dedicated to spreading cleaner production methods, mainly CFC-free processes, within the electonics and other industries. 50/

12. The International Standard Organisation (ISO) in Geneva to which more that 90 countries belong, has recently approved the establishment of the Strategic Advisory Group on the Environment which will deal with issues of environmental auditing, eco-labelling systems etc. Among its first priorities will be the international standardization of environmental symbols and terms (i.e. recyclable/recycled/biodegradable and corresponding graphic symbols etc.). 14/

C. Opportunities for building a special cleaner production capacity

ESID/CP requires cooperation and the sharing of data locally, nationally and internationally which can best be done by national and international trade/industry associations in workshops, congresses, newsletters, projects, publications, training packages etc.

Such organizations can have a profound effect on managers of industrial enterprises by creating a standard of "environmental business management" from workers to top management in each enterprise, by resolving practical problems with regular working groups and by producing credible role models for other enterprises.

Chambers of Commerce can encourage cleaner production for the benefit of their own communities with localized activities and even with local annual external environmental audit systems which recognize and encourage enterprises that meet local environmental standards.

In 1991 the German Environmental Management Association (BAUM), which has been working since 1985 at a grass roots level with all size companies, helped to form a federation of similar organizations in other countries called INEM - the International Network for Environmental Management - which has member and partner organisations in: Germany, Austria, Sweden, the United Kingdom, Denmark, South Africa, Israel, Switzerland and the United States of America and is planning for members in France, Brazil, Hong Kong, Japan and other countries.

INEM plans to concentrate on environmental management with a range of international cooperative activities including: seminars, workshops, research and education, congresses, publications etc. and a global network of member associations. INEM seeks to reconcile business and environmental objectives by encouraging enterprises to deal with environmental problems in an acceptable order: first, compliance with the law; then changes which are profitable to the enterprise; then changes for which the cost/benefit to the enterprise is neutral; and finally changes that require new cost or investment.

X. INDUSTRIAL EXPERIENCE OF R&D, MANAGEMENT AND TRAINING METHODS

A. Research and development hardware: technology

As stated in the beginning of this paper, sustainable development for industry must reflect sustainable development in nature: a highly efficient closed loop in which each element of the loop passes on its end-products to the next link. Our present practices reflect a linear mentality which assumes nature is a bottomless well of resources and a bottomless pit for our end-products. R&D must focus on the complete process from design to eventual recycling or reuse of the constituent materials (e.g., design for disassembly to cars, appliances etc., that is design them so that they can be easily reprocessed at the end of their useful first life).

ESID means using more "circular" processes and technologies, ideally using materials which fulfill their functions inherently with minimum external input of energy and information. The following case gives an example of a material which fulfills its functions by virtue of its inherent molecular properties:

> Case: CloudGel - this normally transparent substance which can be incorporated in windows becomes cloudy when the sun hits it directly and heats it beyond a certain point, decreasing the amount of heat coming in and thus reducing cooling costs.

Such efficient automatic feedback systems are the hallmark of the future materials and technologies which will make ESID attainable. These requirements clearly set out the target for ESID/CP Research and Development. Various companies have put ESID/CP into their R&D priorities, to try to identify "unacceptable materials, products and processes" because they recognize the need to start now, to research for alternatives which may take several years to develop.

The problem with many R&D programmes is a focus on current technology, rather than the "optimal processes" and "optimal products" required by ESID/CP. Similarly such R&D may often seek to merely comply with existing legal standards, rather than anticipating more stringent future environmental standards.

Many technological developments presently considered "impossible" may be confidently expected. Bio-technology, genetic engineering, material technology and advances in computer and communication systems (to diminish the highly adverse environmental effects of mass travel and great concentration of people in one work or leisure place) may well provide unexpected benefits for ESID/CP in the future.

Industrial R&D has already developed a wide range of synthetic chemicals and it is here that biotechnology has much to offer as specially manipulated organisms can be tailor-made with the required capacity to tackle novel forms of environmental contaminants. Bacterial recycling of pollution and waste is just beginning and will require cooperative collection and management of waste disposal. Special controls on bio-technology and genetic-engineering may help to prevent severe environmental accidents, due to unforeseen outcomes. As usual, the management problems will continue to be more difficult to resolve than technical problems.

As computer-aided design, computer-aided and integrated manufacturing, robotics, and other manifestations of the micro-electronic revolution continue to enter the factory, we can expect simultaneous improvements in industrial productivity, product quality and flexibility and environmental performance.

B. Selected examples of R&D hardware initiatives

1. Bio-technology - A bacterial strain digests cellulose and phenol-formaldehyde components of scrapped East German Trabant cars without producing the dioxins of incineration. 51/

2. Cooling/food conservation - A French SME has developed a series of processes and mobile devices enabling inexpensive high quality conservation of plants and foodstuffs for long periods; including recently a relatively inexpensive CFC-free cooling system scalable from car air-conditioning units to large cargo ship size, already in use in the refrigerated trucks of the largest French retailing group. 14/

3. Leather technology - UNIDO projects in the tanning industry of various developing countries (Indonesia, Kenya, Costa Rica, Viet Nam etc.) all include special assistance to leather R&D establishments for the development and testing of new cleaner production applications, to achieve both economic and ecological benefits.

4. Pulp/paper technology - With UNIDO assistance, Turkey is establishing a large-scale desilication plant at the Afyon pulp and paper mill. In collaboration with the Central Pulp and Paper Research Institute of India, joint semi-pilot scale trials have achieved an 80 per cent reduction in the silica content of black liquor, which can now be recycled and cause less pollution. This cooperative project should achieve both economic and environmental benefits; and furthermore it should demonstrate the efficiency and effectiveness of cleaner production cooperation between developing countries.

5. Bio-technology - India has a major biotechnology research programme for industry covering: anaerobic and aerobic treatment systems, degradation of aromatic and aliphatic hydrocarbons, bioconversion of solid organic wastes, microbial degradation of chemical pollutants. 52/

6. Motor technology - Chrysler and GM are doing research on electric cars to cut greenhouse gas and air pollution emissions, while Honda is researching lighter cars and Mercedes-Benz hydrogen powered vehicles. Meanwhile Volvo is developing a superior vehicle based upon flexible fuel, environmentally less-harmful refrigerants, three-way catalytic converters and plastic parts designed for recycling. 1/

7. Coal technology - New "clean-coal" technology has led to UNIDO pilot/demonstration plants in several countries including Poland and China (liquification of high sulfur coals), Korea and India (fluid bed combustion and gasification of high ash coals) and Bulgaria (pulverized fuel combustion of low rank ignite).

8. Bio-technology - The copper industry has used the same basic methods of ore smelting for six millenia with extensive pollution. During the 1980s, bio-technology was introduced in the form of "Thiobacillus ferrodoxins" which now accounts for 30 per cent of US copper production and is credited with saving the industry. 8/

9. New materials - Ceramic motors can withstand higher temperatures than metallic motors and therefore reduce the proportion of unburnt fuel in exhaust gases thereby reducing air pollution. 53/

C. R&D software: management and training methods

Similarly, various companies doing R&D by experimenting with new management and training systems, which seek to create organizational environments for ESID/CP developments, arise spontaneously at all levels.

Business schools and NGOs are beginning to research ESID/CP and publish appropriate material; they are trying to produce professional (Harvard Business School type) case studies but find companies still reluctant to release environmental data which is professionally researched rather than "success stories" for public relations. Few companies are willing to release hard data on environmental problems, because it may be misinterpreted or used in damage claims against them.

According to inventors, some of the main barriers to innovation, hindering the rapid introduction of ideas and inventions in the field of environmental protection, include established companies' cartel-like protection of markets against environmental innovations, as well as a multitude of restrictive standardisation, safety and administrative measures which have not kept up with technical developments. 19/

Research is needed into the reality of environmental management audit and annual external environmental audit of industrial enterprises. Will it be a public relation exercise or a continuing tool for motivating creative management? Perhaps when annual external environmental audits become as accepted as professional financial audits, they will be one of the major motivators for ESID/CP in many enterprises.

D. Selected research and development software initiatives

1. Bio-technology - UNIDO projects now include expert missions to Algeria, Indonesia, Mexico and Venezuela to advise on the application of bio-technology for environmental oil clean-up.

2. Cleaner production databases - Several cleaner production databases have been created recently. ICPIC, the International Cleaner Production Information Clearinghouse is a joint venture between the US EPA and by UNEP/IEO. It has two nodes (Paris and Washington, DC), is free of all charges and contains more than 400 case studies of cleaner production. 53/ The Deutsche Bank has a slightly different database which contains the name and contact information for companies specialized in solving particular cleaner production and environmental problems (e.g., bacterial decontamination). 54/

3. Genetic engineering control - UNIDO in collaboration with UNEP/WHO/FAO is formulating a draft Code of Conduct for the release of genetically modified organisms into the environment, for industrial and other applications; this will be presented to the UNCED Conference.

4. Paper Technology - UNIDO is working with Asian countries in a cooperative regional programme to set up a relationship between six pulp and paper research institutes for joint research projects, technology transfer, and a network for ongoing exchange of information and staff.

5. Waste management techology - UNIDO is planning a new project in Kenya to study the required infrastructure and management needs for local production of environmentally oriented industrial products including equipment for air/water treatment equipment, refuse collection, waste recycling and pollution control.

6. Management - The Federal German Government has asked six research organisations to research the state of ESID/CP in 600 industrial enterprises representative of the German economy. Preliminary results were published in 1990 and the study, the largest and most comprehensive of its kind to date, is expected to continue in the future. 55/

7. Oil Industry Technology - In Thailand, UNIDO is studying the potential for collaboration with oil industry transnational companies, to establish an oil waste recovery facility/system which would recover the waste and produce significant economic and environmental benefits.

8. Management - Price Waterhouse/AGL are researching environmental auditing practices to develop training packages for managers and environmental auditors. The packages will relate environmental auditing to the professional auditing skills alreadv applied to financial audits, management audits, energy audits and social audits etc. 1/

9. Information - UNEP/IEO's quarterly newsletter "Clean Production" provides a summary of ESID/CP development and training activities in developed and developing countries. 28/

E. Opportunities to building a special ecologically sustainable industrial development and cleaner production capacity

Research and development can reach out towards the new concept of clean technology with "optimal products" and "optimal processes" with pollution prevention and resource conservation, and with new products that satisfy currently unmet needs. Processes will move towards "zero waste/pollution" and products will be managed in their life cycle from material extraction, manufacturing, use and disposal.

Research and development from the new biological, material and computer technologies will probably achieve presently "impossible" objectives. However the main difficulty with ESID/CP will not be technology "hardware" but the management "software". If management acts honestly to empower their employees and unleash their creativity, technology and processes will follow. Management problems may lie in the lack of political will or institutional capacity, or the unwillingness to devote adequate financial resources to environmental objectives, or in the conflicts within Industry/Government and associated institutions. Thus R&D on management and the means to obtain top executive commitment for ESID/CP is a key priority, especially in developing countries.

Authorities should promote institutions providing free and unbureaucratic advice to inventors of CP/ESID materials or processes. Forums should also be created where innovators have a chance to present their ideas and discuss them with representatives of public authorities, chambers of trade, industrialists and the press. Finally, environmental R&D should be fiscally encouraged.

TNCs should not hinder SMEs' efforts to introduce new environmentally beneficial processes even if their own immobilized capital prevents them from doing the same. Better to cooperate with the SME in introducing the new technology on a larger (global) scale and gradually write off the outdated equipment.

In a nutshell, new management systems and training methods are the critical challenge if ESID/CP is to become the "normal" rather than the "exceptional" course of action in the industrial development of the future.

XI. CONCLUSIONS

1. The key problems of ESID and CP are probably not technical, but more political, economic and social. This may well be due to the conflicts, divisions, diversity and disparity within industry and government and associated institutions, which prevent them from reaching a consensus on what to do.

2. CP, which seeks "low/zero-waste" and "low/zero-pollution", can become viable and even "optimal" for new industries and products of the future. Old industry must be content with relatively cleaner production until it becomes technologically obsolete. Thus cleaner production is harder and will need special support to motivate action. This is particularly acute in the case of developing countries.

3. Cleaner production needs "performance standards" which provide flexibility and motivate innovation; it does not need "technology standards" which lock attitudes into the current technology.

4. Cleaner production in industry is mainly motivated by business objectives for market advantage, profit and risk reduction; thus environmental benefits are a by-product not a key objective. The best motivators for an enterprise to be open to cleaner production are that full environmental costs have been internalized, and that competitors are doing cleaner production profitably, thereby offering acceptable "role models" for action.

5. Government can create the rules for ESID and CP through environmental standards, enforcement, taxes and grants, whereby pollution control and resource economy become relevant costs and benefits of the enterprise and therefore motivators for cleaner production.

6. Cooperative effort between enterprises, transnationals, governments and trade associations can set up associations and role models for environment-conscious business management in each country.

7. Cooperative effort between industrial and trade union organizations and government can develop the positive environmental legislation that motivates cleaner production development as part of an integrated system of environment-conscious business management.

8. Special R&D aid to industry in both developed and developing countries can make cleaner production technology transfer viable and self-sustaining, provided it is associated with new technology and development of human resources with appropriate annual external environmental audit.

9. Much work must be done to establish a relationship of mutual trust between developed and developing countries when discussing ESID and CP. It must be demonstrated to the developing countries that international cooperation in cleaner production must be an inseparable component of any programme to attain sustainable, socio-economic development.

10. There is a generation gap on the practical value of ESID and CP between the older and younger industrial managers; in some countries developing the new younger managers may be easier than trying too hard to change the older ones.

XII. RECOMMENDED ACTION FOR UNIDO

1. Introduce ESID/CP into all current and future UNIDO projects with special training components/materials, which can be adapted for needs of each country, industry and enterprise. Train all UNIDO staff in the concepts of sustainable development, ESID and CP, and on how to translate these ideas into technical cooperation.

2. Set up a "UNIDO Low-Cost CP Programme" with research, manuals, publications, conferences, training packages and UNIDO certificates for enterprises that comply. Demonstrate that with simple "production engineering housekeeping", a high degree of cleaner production can be achieved with no new investment and at little or no cost. For example, use cost reduction through energy savings to open the doors. Make the programme realistic and practical for a CRITICAL MASS of enterprises in each developing country. Start with Indonesia (population 180 million) where APINDO, the employers' organization, is keen to work with UNIDO in ESID/CP for its 5,000 members.

3. Set up pilot schemes in developing countries for cleaner production technology transfer to manufacture new products to provide cleaner production role.

4. Create a series of UNIDO ESID/CP fellowships for younger managers in developing countries.

5. Develop UNIDO procedures and professional training for environmental management audits and annual external environmental audit. Encourage chambers of commerce to set up simple audit schemes for their members; encourage industrial associations to develop simple systems for their particular industries.

6. Design quantitative measures of ESID/CP whereby the current status and annual progress can be measured and publicized in the form of simple indices.

7. Expand, in cooperation with UNEP/IEO, the present, EEC-wide Better Environment Awards for Industry for other countries and regions.

8. Develop with UNEP/IEO group-based ESID/CP training packages, designed to be easily adaptable for the special conditions of enterprises and industries in different countries. Promote such training to a critical mass of industrial managers every year.

9. Develop and publish a directory of training resources for ESID and CP (or databases such as UNIDO's Industrial and Technological Information Bank (INTIB) and UNEP/IEO's International Cleaner Production Information Clearinghouse (ICPIC).

10. Work to establish a relationship of mutual trust between industrial enterprises and the industrial sector in general in developed and developing countries for ESID/CP through the organization of consultations and global, regional and sub-regional fora for the exchange of experience on ESID/CP.

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GOVERNMENT INITIATIVES IN ACHIEVING ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

Working Paper No. IV

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CONTENTS

I. INDUSTRIAL AND ECONOMIC BACKGROUND

1. Global industrial growth in the last two decades has seen a higher average annual growth in manufacturing value added (MVA) for developing countries as a whole compared to that of developed countries. Even so, the benefits of this growth in industrial output have been eroded by the comparatively higher rates of growth in population resulting in a significant decline in standards of living, as measured by per capita income. 1/

2. Moreover, the industrial-growth sectors in developing countries have mainly been resource-based light industries and capital-intensive industries producing basic materials. These highly resource-intensive industries, using large quantities of water, energy and raw materials, are at the same time pollution intensive, generating a large variety of pollutants and industrial wastes including toxic substances. 1/ This has grave implications for the physical environment in developing countries, and underlines the fact that the issue of environmental deterioration is one of the major concerns facing humankind. Society has become increasingly aware of the problems of environmental degradation due to a number of factors such as the following:

(a) Acute income and population concentration caused by the process of urbanization. In many countries this has led to agglomerations of substandard dwellings without minimum sanitation or environmental infrastructure. The social perversity of this situation has increasingly been recognized by organized groups within society;

(b) Low levels of public health services, particularly in regard to basic sanitation, in the developing countries, creating the conditions for certain diseases to remain endemic, while others associated with environmental deterioration become more widespread;

(c) Growing numbers of combustion-engine vehicles resulting in increased air pollution;

(d) Environmental disasters due to the indiscriminate use of certain products and raw materials;

(e) Development of the chemical, steel, fertilizer and petrochemical industries, which have a high degree of potential for polluting the environment.

3. The degradation of the environment, in its totality, cannot be attributed to specific projects. Rather it is a consequence of a very large number of small, sometimes separately insignificant, activities by individuals or enterprises of all sizes. In this process the role of agriculture, transportation, heating and energy production is predominant. But a share of the deterioration of the physical environment must also be attributed to the manufacturing industry.

4. Despite its potential environmental costs, the primacy of industrialization for the developing countries is beyond dispute. Much more important, industrialization could help to provide a cure for environmental problems, if an environmentally sound industrial development strategy were pursued. Such strategies call for the integration of environmental concerns into industrial development plans and policies at the initial stages of formulation.

5. Until recently the environment has not been treated as a scarce resource. There have been no markets for and no price on environmental resources such as air, water and soil. This has resulted in an over-exploitation of such resources and has underlined the need for an ecologically sustainable industrial development (ESID) strategy that would aim at rectifying the misallocation of such resources by government intervention and appropriate environmental policies. Such policies, however, must be in line with a broader economic perspective, especially the need to foster environmentally favourable investment conditions in developing countries. Environmental policies, regulatory instruments and economic mechanisms are necessary but not sufficient conditions to achieve ESID. They must be accompanied by increased investment, a reshaping of the international community and a global partnership to ensure an improved quality of life for present and future generations.

6. Among the many issues presently facing the international community, the following are relevant to promoting ESID:

(a) New technologies give the industrialized countries superiority in industry and agriculture;

(b) The difficulties preventing the developing countries from controlling inflation, the lack of investment there, and the deadlock over external debt have distracted the attention of Governments from effectively tackling environmental problems associated with industry;

(c) The environmental challenge is one of the few areas of global interdependence that could act as an incentive to increased cooperation between members of society and between countries at different stages of development.

7. The way forward for a country lies in mobilizing its own resources and potential to modernize its economy, stimulate its young people to participate in and to build a democratic, ecologically responsible and socially equitable country. This process can be facilitated by the adoption of sectoral and regional strategies based on proven competitive advantages. For their success, such strategies depend, however, on joint inter-organizational efforts resulting in actions aligned to national priorities (education, regional integration, job creation, reduction of inequality) as well as international goals (globalization of markets, environmental awareness, technological and industrial modernization).

8. Most of the policies and policy instruments described in the present paper are not specific to industry, but are intended to influence the economy as a whole. Nevertheless, when applied they would have an impact on the industrial structure (sectoral distribution, location, size of enterprises etc.) and on the choice of technology.

II. THE NEED FOR GOVERNMENT INTERVENTION

A. Environmental deterioration in the economic context

9. Environmental resources (air, water, soil) are often treated as free goods or as common properties to which no individual rights exist. This could lead to a conflict between private and social interests in the use of such

resources. Since the price of goods and services do not include any cost for the use of environmental resources, the price structure is distorted. The resulting negative externalities necessitate government intervention to rectify this market failure and internalize the cost of using up environmental resources.

10. Thus, there are sound economic reasons for government intervention in the process of environmental management in order to attain the objectives of maintaining environmental quality.

11. The principal roles to be played by the Government in intervening in the process of environmental management are the following:

(a) Internalization of costs of damages to the environment;

(b) Determination of the correct price for environmental resources that are being depleted.

This may be done either by the formulation of new policies or by the elimination of inappropriate policies (both industry specific as well as general) that fail to take environmental considerations, employment, health, sanitation etc. adequately into account in the promotion of industrial development.

12. One way of dealing with the internalization of environmental costs is for Governments to adopt the principle that the polluter pays, which is discussed below.

B. The polluter-pays principle

13. The preceding section highlighted the need for Governments to participate in solutions to environmental problems, whether these problems are seen as being due to failures of the price system or due to shortcomings in the establishment of property rights over environmental resources.

14. Major environmental problems are negative externalities imposed on third parties. In other words, the cost of actions taken by one party are borne by other parties who are not directly involved in the process of production or consumption that gave rise to these externalities.

15. If the party responsible for causing environmental damage is not made liable for doing so, it will have insufficient interest in solving the problem. So if solutions to environmental problems are to be found, it is important to make those who cause them accountable in monetary terms for the damage done. This means adopting the principle that the polluter pays.

16. The polluter-pays principle was defined by the Organisation of Economic Co-operation and Development (OECD) in the 1970s and is applied in most OECD countries. 3/ It implies that the polluter must assume the cost of pollution-reducing measures rather than the State or the general public.

17. The principle may become a reality by the use of economic instruments, such as taxes, fees and charges levied on pollution. Such instruments have been adopted in several countries and will be analysed in the following chapter.

18. The principle is highly important in the development of environmental policy, owing to a number of factors, among which are the following:

(a) The gap between private and social costs can be narrowed;

(b) Making this principle known to the general public can improve public awareness of and attitudes on ESID;

(c) Methods of pollution prevention, including non-polluting technologies, and control are likely to be introduced more quickly.

III. REVIEW OF POTENTIAL GOVERNMENTAL INITIATIVES TO ACHIEVE ENVIRONMENTALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

A. Instruments of intervention

19. The instruments that are available to Governments for implementing ESID can be categorized in different ways. One possibility would be to characterize them according to the time perspective in which the impact is expected. Some measures aim at solving a critical problem as soon as possible; an injunction may be used. Other measures, such as awareness programmes and green lables, will aim at changing the behaviour of the consumers or the producers in the longer run. The classification used herein is based mainly on the one used by OECD, 4/ which distinguishes between regulatory and economic mechanisms. A third category has, however, been added, that is, mechanisms for strengthening the institutional framework.

20. The end of this section contains a detailed discussion comparing regulatory and economic measures. However, a few points are highlighted here.

21. Legal and regulatory measures are intended to control directly behaviours that may result in environmental harm. Regulated actors must comply or else face sanctions. Economic measures provide incentives or disincentives that are intended to influence economic decisions that have environmental consequences. They normally allow some flexibility to the environmental actor in deciding how to proceed.

22. The distinctions between these two approaches tend to become blurred in practice. Many measures to directly control environmental impact by law or regulation have an economic component. Many economic instruments are based on, or set forth in, laws and regulations.

23. It is also of fundamental importance to note that because an instrument is "available" does not mean that it can be used by any Government under all circumstances. The instruments must also be "permissible" and "relevant". For an instrument to be permissible it must be in line with policy objectives and constraints adopted by the Government in question. To be relevant the instrument must address a problem relevant in the country in question and in such a way that the effect is assured. For example, taxes as instruments, however efficient, would hardly be effective if there were no efficient system for tax collection. Equally, instruments that would be harmful for export production could be problematic in countries where the export objective has priority over all others. In general terms this problem is discussed in chapter IV, which deals with the combination or mix of different instruments in the design of ecologically sustainable industrial policies.

24. The foregoing is particularly relevant for developing countries where priorities, needs and constraints are often fundamentally different from those of industrialized countries in which pollution-control policies were first developed and government instruments designed. In practice, it has to be taken into account that the number of available instruments that would be permissible and relevant in developing countries is considerably smaller than in industrialized countries. Since the pollution problems often are of a transboundary, regional or global nature the resulting dilemma, or goal conflict, has to be resolved through international cooperation between Governments (see working paper V).

25. What follows is a discussion of these mechanisms and an indication of their usefulness as a means for promoting ESID.

B. Regulatory mechanisms

26. The preferred way for Governments to encourage ESID related objectives has been through statutes or legislative statements of environmental quality objectives to be achieved through regulatory regimes. Statutes enacted by government bodies can be specific, but all require clarification or refinement to make the regulatory regime operational. Regulations establish the particular policies and procedures that an environmental management agency uses to carry out its statutory goals.

27. The creation of environmental property rights in the United States of America, in the form of emission credits that can be traded in the market, granted to corporations that control pollution, is one example of a government intervention. Other illustrations of the need for government intervention in the United States are manifest in the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). RCRA was enacted to deal with problems of hazardous waste disposal that had been brought to public attention as a result of a series of accidents. CERCLA envisaged the setting up of a trust fund financed mainly by taxes on chemical manufacturers for compensation in cases of environmental degradation and accidents.

28. In developing countries, the role of the Government has traditionally concentrated on the setting of standards and legislation. In India, for example, there are three specific acts of legislation: the Water Prevention and Control of Pollution Act 1974, the Air Prevention and Control of Pollution Act 1981, and the comprehensive legislation of the Environmental Protection Act 1986. In addition, government institutes such as the National Environmental Engineering Institute and the Central Pulp and Paper Research Institute are conducting research in environmental protection. Similar government-supported institutes are found in China, Indonesia, Myanmar and other countries. 2/

29. A regulatory regime consists of four activities: standards, permits, monitoring compliance and enforcement. The major purpose of these four activities is to encourage, guide or prohibit future conduct that would be detrimental to the environment.

1. Developing standards

30. The first essential element in most regulatory programmes is to issue standards that clarify an agency's approach to mitigating environmental

problems. These standards, which set pollutant-discharge limitations, are usually determined in one of three ways. Technology-based standards specify the discharge limitation based on the availability and affordability of technology, without consideration of the quality of ambient environment. The effluent guidelines for water-pollutant discharge issued by the United States Environmental Protection Agency are an example of this type of standard, which is frequently copied by developing countries. Ambient-based standards specify a safe or clean environment based on the protection of human health and welfare, without consideration of cost or technological feasibility. The ambient standards for air and water quality issued by the World Health Organization (WHO) are used by many developing countries for setting their ambient environmental standards. Between these two extremes, benefits-based standards focus on the trade-off between the risks to society from pollution and the costs society must pay to reduce pollution. This balancing approach could be of considerable use to developing countries because of the limited capital available for environmental management.

2. Issuing permits

31. The second essential element in most regulatory programmes is to ensure that pollutant-discharging facilities obtain operating permits. Permits tailor national standards to individual facilities and their environmental circumstances. An essential element of a permitting programme is an inventory of pollutant sources. Usually, at this point in the regulatory process, there is room for negotiation between the Government and the regulatory community.

3. Monitoring compliance

32. The third element in most regulatory programmes is to monitor the compliance of facilities with the conditions of their permits. There are four sources of compliance information: (a) self-monitoring and reporting by the source of pollutants; (b) inspections by government officials or independent third parties; (c) citizen complaints; and (d) ambient monitoring. The mix of information sources used varies from one country to another, but self-monitoring and inspections are by far the most important means of compliance monitoring.

4. Enforcing permit conditions

33. The fourth element in most regulatory programmes is to provide a wide range of enforcement responses to violations of environmental operating permits. Traditional enforcement sanctions fall into four general categories (informal, administrative, civil and criminal). A variety of informal responses, such as warning letters and telephone calls, fall at one end of the enforcement spectrum. Beyond these informal responses, environmental agencies use administrative, civil and criminal remedies and sanctions.

34. This regulatory regime, often described as command and control, does have its strengths. It provides the public sector with some assurance that technically and economically feasible actions are being taken to abate pollution. It gives the industrial polluters a reasonably predictable target that they must achieve, and generally protects competitive positions by imposing uniform requirements. Lastly, in industrialized countries, this regulatory mechanism has scored notable environmental successes, albeit at a higher financial cost than necessary. Water quality has improved following reductions in organic pollutants and air quality in urban areas has improved in the wake of reductions in particulate matter and sulphur oxides.

35. This regulatory regime also has its weaknesses. It has not been particularly effective with regard to managing pollution from small- and medium-sized facilities, or from nonpoint sources, such as runoff of pesticides and fertilizers from agricultural activities. In some cases, it has achieved its success at a very high cost because of its uniform requirements and emphasis on technology-based standards, which can restrict industrial flexibility and discourage innovation. Also, the past tendency to regulate by environmental media (e.g. air, water, soil) has tended to shift environmental problems from one medium to another (e.g. switching from burning garbage to dumping it in the ocean).

36. Most developing countries over the past 20 years have adopted some environmental statutes or legislation, but have failed to create a regulatory regime to achieve environmental objectives in industry and other sectors. A worldwide survey by WHO in 1985 highlighted the lack of the basic elements of a regulatory programme. 2/, 5/ Of the 59 developing countries that are industrializing more or less rapidly, only 10 had most of the key programmed components, 29 had some and 20 had few or none. Not one of the other 76 developing countries had any significant institutional capacity in environmental management. A survey by UNIDO in 1990 of industrial wastewater management in seven African countries showed that all seven had some form of legislation or statute, but that only one had the essential elements of a regulatory programme. 1/

37. There are a number of constraints in many developing countries that can make it particularly difficult to successfully implement regulatory regimes. Government institutions usually lack sufficient resources to carry out programmes that involve establishing, monitoring and enforcing sophisticated technical requirements. Broad use of enforcement mechanisms may not be readily accommodated in non-litigious cultures, particularly in Asia, or may be undercut in situations where poor economic conditions lead to corruption and bribery. It may sometimes be better to have no regulatory programme or a very modest one than a programme that cannot be effectively administered and so undermines the Government's credibility.

38. Three case-studies have been chosen to illustrate different aspects of pollution control. The first, on watershed management from Indonesia, illustrates the use of regulatory mechanisms.

Case-study one*

39. The Kali Surabaya Pollution Control Program (KSPCP), located in the Brantas River Basin of East Java, was the first comprehensive effort to reduce water pollution in Indonesia. Programme components include: developing industrial waste treatment facilities; improving sanitation; building institutions; and training personnel to monitor discharges of liquid wastes. The programme is administered by the Ministry of Public Works Directorate General.

40. An initial review in 1985 identified four factories (a sugar mill, two paper plants and an MSG factory) that were responsible for 77 per cent of the pollution in the Surabaya River and 94 per cent of the industrial pollution in

*Based on Economic Policies for Sustainable Development (Asian Development Bank, 1990).

the programme area. During the years 1986-1988, KSPCP concentrated on pollution abatement for these four facilities and on improvement of domestic sanitation facilities for communities along the Surabaya River. The factories received notice to comply with discharge regulations and they agreed to implement pollution-abatement measures by the end of 1987. These measures included recycling some waste materials and using recirculated water.

41. All four factories implemented the agreed-upon measures by the deadline. Overall pollution reductions were approximately 80 per cent. During the same period, pollution from domestic sources declined by 25 per cent, and pollution from smaller industrial sources by 10 per cent.

C. Economic incentives and disincentives

42. The treatment of environmental resources in traditional economic theory as free goods and/or public assets has resulted in a misallocation of these resources, which in turn has had negative social and economic implications. For example, air and water are considered free goods that produce benefits for which users need not be charged. As a result, industry is not motivated to invest in the conservation or improvement of environmental resources that in the first instance are of social relevance.

43. Moreover, if natural resources, such as air, water and land, are seen as public assets and utilized without limitation, the benefits of such utilization are privately enjoyed, while the costs are socialized. Finally, if prices, being the foundation of a market economy, do not reflect the environmental cost of production processes, they fail to perform their role as a rationalizing force in the market.

44. The potential role of government policy should therefore be to establish the link between resource scarcity and prices in order to improve resource management and promote sustainable development.

45. The adoption of economic incentives and disincentives in environmental management systems is of increasing importance for an effective approach to the problem. The approach must address the following aspects of policy reform:

(a) Internalization of environmental and social effects of industry policy;

(b) Correction of market failures;

(c) Elimination of market-distorting policies (e.g. elimination of pesticide subsidies). 6/

46. The economic mechanisms that are suitable for inclusion in environmental management systems are discussed below. They are fiscal measures (taxation, accelerated depreciation, elimination of subsidies, tax exemption, government procurement); direct financial support (concessional financing, subsidies); and tradeable permits and insurance.

1. Fiscal measures

47. Different countries at different times have adopted fiscal incentives to encourage the implementation of pollution-control systems. Similarly, it is possible to adopt fiscal incentive schemes to promote ESID. Among such measures, the following should be emphasized:

(a) Pollution taxes, making it expensive to cause pollution and encouraging the implementation of pollution-prevention systems;

(b) Application of the mechanism of accelerated depreciation to foster investments in pollution-prevention and waste-minimization systems as well as pollution-control equipment - companies can use this method to depreciate their equipment quickly, thereby artificially increasing costs and reducing the amount of corporate income tax due;

(c) Elimination of subsidies in order to reveal the actual prices of goods;

(d) Tax exemption for pollution-control equipment as well as for the adoption of clean technology, thus reducing the cost of such equipment and technology;

(e) Government expenditure, that is, the use of its purchasing power.

(a) Taxation

48. This is one of the most widely used mechanisms for pollution control. Taxation is one means of implementing the polluter-pays principle, based on the monetary liability of the polluter for damage caused. Funds raised by taxation can be used to set up funds for financing activities for pollution prevention. Production processes that pollute are taxed in such a way that the cost of the environmental damage caused has to be incorporated into the cost of the product. This should induce the polluter to implement environmental-control systems more quickly.

49. The degree to which effluent emitted by an industrial company is treated becomes a decision the company itself must take, since it will have to pay society for cleaning up the pollution it causes, and thus to provide the resources required to treat the remaining portion of its effluent or waste. This inducement is highly relevant to ESID, since it can effectively lead to a change in behaviour resulting in the adoption of technologies that consume environmental resources less intensively and are cleaner.

50. Taxation schemes can be found in practice in a number of countries. France uses taxation to control water and air pollution. In the case of water pollution, the French system comprises six basin agencies that are responsible for taxing polluters, whether they are industrial firms, individuals, farms or municipal governments. As an illustration, the agency for Seine-Normandie, corresponding to the Paris region, levied the equivalent of $US 250 million in 1990 alone. These funds in their entirety will be invested in water-pollution control in the same region. 7/

51. In the case of air pollution, Decree n. 85.582 of 7 June 1985, set a charge of F 130 per tonne of sulphur dioxide emitted for companies that emit more than 2,500 tonnes per annum. In France the principle of self-financing is important. Funds from the public budget are difficult to obtain. In the case of water-pollution control the main source of financial resource is the funds from taxation, and that is well accepted.

52. Germany has a water-pollution taxation system. Water quality in that country has improved considerably since the charge system has been in operation. The Netherlands has a water-taxation system. The water-pollution

charge is felt to be effective and has introduced strong pollution control incentive impacts on certain industries. 4/

53. Australia, Belgium, the Netherlands and the United States apply charges on solid wastes. The United States levies taxes on raw materials whose processing creates hazardous wastes. In principle the aim of taxation as a pollution-control mechanism is to change the behaviour of users of the environment, leading them to consider the introduction of clean technologies, or at least of technologies that consume less resources in the production process, as has already happened in several countries. However in practice the charges are low and unlikely to affect behaviour in a significant way. This mechanism alone is insufficient, others must be found to complement it.

(b) Accelerated depreciation

54. Depreciation is the reduction in value of an asset through wear and tear. An allowance for depreciation on a company's real estate, machinery, equipment and vehicles is permitted in its accounts before calculating profit on the grounds that consumption of capital assets is one of the costs of earning the revenues of the business. The pertinent legislation establishes the asset life to be taken as a basis for these calculations. If a firm increases depreciation, either by increasing the number of assets to be depreciated or by reducing the useful life considered for depreciation purpose, it increases its costs and reduces the corporate income tax payable.

55. Depreciation acceleration is used as an incentive in several countries with the aim of stimulating companies to introduce pollution-prevention systems, thereby reducing the impact of the cost of environmental control on final costs. Among these countries are France, Japan and the United States.

56. In France, the law allows accelerated depreciation in the first year of 50 per cent of the value of all construction required for the installation of facilities for water-pollution control. Application of the depreciation mechanism to equipment for air-pollution control is also permitted under specific legislation.

57. In Japan, the mechanism of accelerated depreciation, used in the 1970s, was the most important benefit granted to companies implementing pollution-control projects. This permitted depreciation in the first year of 50 per cent of investment in such systems.

58. In the United States, the 1976 Tax Reform Act provided for accelerated depreciation both of environmental-control projects and for equipment that is not specifically designed for pollution control but contributes to a reductior of emissions.

(c) Elimination of subsidies

59. Several countries follow policies of economic growth based on the granting of subsidies to a number of productive activities. These subsidies may take many forms, such as concession of long-term loans at low interest for the implementation of certain activities; tax breaks for certain activities; price controls; and protection of domestic markets for producers operating locally.

60. An economic growth strategy that does not adequately account for environmental concerns and based on governmental stimulation through subsidies may

lead to the over-utilization of natural resources. In Brazil, for example, in recent years there have been cases where subsidies have led to more intensive use of environmental resources. Two of these cases are worth discussing in detail.

61. The first noteworthy case is industrial development in Brazil in the period 1975-1980. This period saw the start of a new stage in the industrialization process, geared to substituting imports of steel products, pulp and chemical feedstocks, and to boosting the shipbuilding industry. Subsidized long-term credit lines were granted to all these industries. The strictly economic aim of import substitution was attained, and indeed Brazil is now an exporter of all the products mentioned. However, the industries are environmentally aggressive, and this is especially problematic since they were set up and stimulated by State financing.

62. The second case is the programme of incentives for fuel-oil substitution by industry. Here the State offered financing facilities to assist the replacement of fuel oil both by electricity and fuelwood. An adverse consequence was an increase in deforestation. In addition to the environmental damage caused, many of the heat-generation systems implemented at that time have fallen into disuse owing to the rise in the cost of fuelwood, and thus there have also been economic losses from inefficient resource allocation.

63. A final feature of Brazilian policy worth noting is that the national development bank, BNDES, which administers the granting of credit lines for many such cases as those mentioned above, gives the same treatment in terms of interest rates and maturities for loans for the acquisition of clean technologies as for those that consume natural resources.

64. The elimination of subsidies for activities that consume natural resources is economically rational and reduces the payment made by society for pollution and environmental destruction.

(d) Tax exemption

65. The objective of the exemption from taxes on pollution-control equipment is the reduction of the final price of such equipment, making their acquisition less costly. Such a policy must be carefully implemented in order to avoid giving excessive incentives to the acquisition of pollution-control equipment instead of production improvements leading to the prevention of pollutant emission.

66. According to a report by the ECE, "In most market economies of the region, fiscal policy is a major instrument of environmental policy-making. A similar approach is also followed by some Eastern European countries. In Hungary, for instance, profit tax allowances granted on the interest payment of environmental investment credit were introduced in 1989. Refunding value added tax on investments for the improvement of water quality, and reducing tax rates for environmental services are now under consideration. In Yugoslavia, expenses of enterprises and organizations devoted to environmental protection may, under certain circumstances, become tax deductible." 7/

(e) Government procurement

67. In contemporary economies public spending represents a sizeable proportion of a country's gross domestic product (GDP), from 7 per cent in

low-income countries to 27 per cent in high-income countries. Part of this is capital spending (investment) and purchase of other goods and services. These two components of public spending account for 4 per cent of GDP in low-income countries, 8 per cent in middle-income countries and 14 per cent in high-income countries.

68. In relation to a world GDP of $US 13 trillion (1990), the two above-mentioned components of public spending amounted to more than $US 2 trillion. This purchasing power can be used by Governments in many countries as a powerful instrument in ESID strategy. Its full potential has not been exploited hitherto.

69. In operational terms, Governments can exercise this power in a similar manner to some non-governmental organizations in the United States. There they publish a list of companies and products that cause environmental problems to serve as a guide for consumers' purchasing decisions. Thus, Governments could set up a system whereby companies with unsolved environmental problems would not be allowed to supply goods or services to the public sector.

2. Direct financial support

70. Several countries offer support to companies that cause pollution, in return for the implementation of pollution-prevention or control systems. Among the most common types of benefit are subsidized financing of pollution-control facilities, and transfers of public funds to pay for part of the control facilities implemented by firms.

(a) Concessional financing

71. The main characteristics of this forward mechanism - low interest and long maturities - reduce the short-term impact of the cost of pollution control on production costs. In order to ensure that there are no distortions in terms of competitiveness, there must be uniformity in the control action established by environmental agencies. In what follows some examples are given of the use of this mechanism in countries where it is relatively common.

72. In Brazil, the Sao Paulo State Pollution Control Program (PROCOP) is a rotating fund that provides a permanent line of credit specifically for companies to develop pollution-control projects. Loans are repaid in up to 10 years with interest at 6 per cent or 9.5 per cent a year (principal is indexed to official inflation). There is also a national programme, POC Ambiental, administered by BNDES.

73. In the United States, where there are a number of types of financing for environmental-control projects, the outstanding examples are the credit lines offered by the Small Business Administration and the Economic Development Administration, mainly in the 1970s. The funds in both cases come from placement of federal bonds with the incentive of a rebate on income tax, so that the cost of money to the final borrower is reduced. The payback period can be as long as 30 years. In some cases, these credit lines are not available and companies must raise the funds required for pollution control on the financial market. Even so, the United States Government can provide guarantees when called upon to do so.

74. In Finland, a pollution-control programme for water was developed with the support of long-term financing for private enterprise. Interest rates

varied from 6.5 per cent to 7.5 per cent a year, well below the market rate of about 9.75 per cent.

75. In Japan, interest rates on pollution-control financing ranged from 6.8 per cent to 8 per cent a year in 1975, compared with a market rate of 9.1 per cent. According to estimates, this subsidy represented 2.6 per cent of the investment made by Japanese companies in pollution control.

(b) Subsidies

76. This mechanism involves government grants to offset part of the costs borne by companies in implementing pollution-control systems. It has been used in the United States, and in France and other OECD countries.

77. In France, any company liable for payment of water-pollution tax is entitled to receive a grant covering part of the funds required for implementation of a water-pollution-control system. 4/

3. Tradeable permits

78. A market mechanism for pollution control, which takes the form of the system of emission rights, has been used in the United States since 1975. It is designed to meet the needs of private enterprise and act as an incentive to the introduction of environmental control systems. The emission rights in question can be traded on the market. 4/

79. Trading in emission rights takes account of a common element, known as emission reduction credits. These credits can be obtained by a company from the environmental agency when it controls its emissions to a greater extent than the law requires. When emission credits are issued they take the form of bonds and can be traded in accordance with the control policy in force in the region in question.

80. Among the strong points of this mechanism are the following:

(a) Motivation to apply the polluter-pays principle, since emission credit trading is a private transaction;

(b) Motivation of emission control by companies at higher levels than the law requires so that they thereby obtain emission credits and keep them for later use;

(c) Possibility of expanding an industrial facility by using emission credits obtained as a result of controls implemented in the original plant;

(d) Possibility of reconciling economic growth with environmental protection by the use of emission credits by companies already operating;

(e) Motivation to introduce clean technology.

81. Although the emission-rights mechanism presents advantages that indicate its suitability for inclusion in an ESID strategy, it is not universally applicable because the rights in question must necessarily refer to the same type of pollution and pollutant. Also it can be complicated to monitor and enforce compliance with the traded permit system.

4. Insurance

82. Ideally any ESID strategy would include a correct evaluation of activities that are of potential risk, and a provision making it mandatory to acquire insurance cover against any damage that such activities may cause.

83. If companies presenting environmental hazards are compelled to insure themselves for this risk, they may rethink their entire operation. Technological choice will be more careful. The available options of implementing pollution control, and operating and maintaining existing pollution-control systems will be chosen more carefully, since this will reduce the cost of insurance.

84. Under pressure from insurance companies, firms will make every effort to avoid damaging third parties, who are also likely to have environmental insurance coverage. The possibility of litigation between insurance companies, or between firms with insurance cover and third parties suing for damages, will force all business organizations to devote far more attention to environmental issues.

85. Another advantage of this type of insurance is that reinsurance institutes will also pay more attention to environmental problems and will force their members to adopt a conservative approach to the negotiation of cover for clients, in order to avoid having to pay for damages in environmental litigation.

86. As a practical matter, however, the advisability and feasibility of requiring such insurance will vary widely in different countries and for different industrial activities.

87. The second of the three case-studies, given below, is chosen to illustrate the combination of a broad array of incentives and disincentives.

Case-study two*

88. Jiangsu Province has the most experience with industrial environmental management in China. This province is the largest industrial producer in China, responsible for nearly 11 per cent of the country's industrial production. The value of industrial output in 1988 was $US 58 billion. Major industrial sectors include machinery and textiles, chemicals, food processing, electronics and construction materials. The province is also one of China's main agricultural areas. Major products include rice, wheat, cotton, rapeseed and silk. Industry generates 68.5 per cent of total social product and agriculture generates 16.4 per cent.

89. Jiangsu is located halfway down China's eastern shore along the Yellow Sea. Its topography resembles large parts of the Netherlands, with an extensive system of rivers, lakes, reservoirs and canals.

90. About 120,000 industrial facilities operate in Jiangsu. Of these, about 70,000 are collective enterprises, many of which are township and village enterprises. Jiangsu is one of only two provinces where the output of such enterprises exceeds that of State-owned enterprises. Some 98 per cent of

*F. Halter, Case Studies of Government Intervention in Industrial Environmental Management, prepared for UNIDO (22 July 1991).

Jiangsu's industrial facilities are small-scale and account for about 75 per cent of industrial output. However, the few large- and medium-scale enterprises account for most industrial pollution. For example, of the 3,000 enterprises in Nanjing, about 35 that are routinely monitored are the major source of water and air pollution.

91. Legal and institutional arrangements for environmental protection in China are more integrated into the framework of government at all levels than in most developing countries. For example, there are fairly well-established legal and administrative procedures assessing the environmental impact of new facilities. A system for accrediting environmental consultants (mostly academic and research organizations) has existed since 1986.

92. National legal requirements establish: economic quality standards for surface water; integrated wastewater discharge standards; and effluent discharge standards for specific industries. In addition, Jiangsu has local standards although compliance with them has been weak because it is technically and economically difficult for industries to meet them. Also, sources tend to dilute their effluent with pumped surface water in order to evade the standards, which set concentration levels (as opposed to mass discharge limits). The 11 municipalities in the province are developing environmental standards that will be adopted for the region.

93. Government efforts to manage industrial pollution reflect a broad mix of approaches, described below. Municipalities usually have more resources and more effective implementation than villages and townships within the province.

(a) Environmental impact assessment is required for new facilities, as noted above;

(b) Pollution levies are assessed against industries, based on the highest polluting constituent. The levies do not take into account any pollution management efforts. The amounts assessed are not high enough to influence facilities' environmental behaviour. Collection rates are much higher in municipal areas. The levies are higher for water pollution than for air pollution. By law, 20 per cent of the levies is allocated to defray the administrative costs of the local institutions that collect them, and 80 per cent to funding pollution control. The demand for pollution control funds is much greater than the money available from levies;

(c) Other sources of funding for pollution control investments include: allowing industries to retain 6 per cent of depreciation allowances for this purpose; using sewer charges to fund the construction of sewage treatment plants; and applying part of the infrastructure charge for new construction projects;

(d) A five year tax break is given on investments in comprehensive waste utilization;

(e) Administrative fines are assessed based on discharge levels above the regulatory standards. Fines are rarely assessed, but even the threat of a fine can be a powerful incentive;

(f) The system for grading enterprise management and designating model managers includes several elements that can affect environmental management, such as: economic efficiency; materials and energy consumption; safety; and environmental protection. An enterprise that incurs a pollution fine or penalty cannot receive a high grading;

(g) State ministries in the industrial sector are supposed to meet targets for improving the recycling and reuse of water, reducing consumption of energy and raw materials, and increasing pollution control investments. This results in some pressure on enterprise managers to pursue these goals;

(h) There is some enforcement of zoning restrictions to help protect water catchment areas and sites that are vulnerable to air pollution. In some municipalities, the Government provides financial assistance to industries that relocate outside of residential areas;

(i) Criminal sanctions. The law provides for criminal sanctions, but no information on their use is available.

94. The Chinese Government is now discussing with the World Bank a programme to evaluate the operation of pollution management measures in Jiangsu, and to examine how to implement some improvements in the system. Improvements would probably be tried first as a pilot phase in selected locations in Jiangsu Province. Possible steps to strengthen industrial environmental management include:

(a) Raising the amount of pollution levies to generate more incentive to reduce pollution;

(b) Placing more emphasis on pollution prevention;

(c) Stressing joint treatment facilities and other shared activities between small- and medium-scale enterprises to achieve better economies of scale;

(d) Extending charges to broader categories, such as industrial use of municipal sewer systems.

95. Another important factor is the low cost of industrial inputs, such as water, energy and raw materials.

D. Mechanisms for strengthening the institutional framework

1. Cultural and social incentives

96. Among several kinds of cultural and social incentives, environmental education seems to be highly relevant. Here dissemination through formal as well as informal channels must be considered.

97. Formal environmental education takes place through the various tiers of the school system, in the teaching of such disciplines as ecology and other matters related to the environment. Some specialists have argued that excessive focus on specific disciplines such as ecology overlooks the principle that the environment is present in all spheres of life, so that the best approach would be a multidisciplinary one.

98. Formal environmental education plays a crucial role in the process of changing the behaviour of society as a whole with regard to environmental issues, and as such it must be given greater attention when priorities are being determined.

99. Informal environmental education consists of the teaching, discussion and dissemination of environmental information outside the formal limits of the

school, i.e. through the mass media, ecological and environmental movements, intensive short courses for specific target groups, political parties, business organizations, trade unions, clubs and so on.

100. Informal environmental education can be an important tool in the process of obtaining ESID, insofar as it enables the society to become more aware of industrialization from the standpoint of their impact on the environment.

101. In Brazil, a formal and informal environmental education programme is being developed by the Sao Paulo state government, under the aegis of its Environmental Department. The formal education segment consists mainly of the publication of classroom texts on the environment and the informal segment consists mainly of support for initiatives designed to disseminate information on action connected to the environment.

102. Another important initiative in the field of informal environmental education is the holding of public hearings as part of the process of assessing environmental impacts by activities such as issuing permits or reviewing national environmental profiles and action plans. At these hearings the community is free to voice its opinions and to assist in the decision-making process regarding introduction of an activity that has an impact on the environment.

103. Use of the educational process in relation to environmental issues is based on the idea that humankind's relation to nature begins at the individual level. If it is possible to alter the individual's conduct with regard to nature, substituting integration for aggression, a major step will have been taken towards adequate use of nature by humans and hence towards sustainable development.

2. Industrial information programmes

104. Utilization of a system for collecting and disseminating information on production techniques and technologies is an essential ingredient for achieving ESID. The importance of this system lies in providing innovation incentives for alternative production processes that can replace processes that consume the environment excessively or are aggressive towards it. Waste recycling, clean energy alternatives, substitute raw materials and changes in production processes leading to environmental gains are some of the items of information that should be studied and disseminated.

105. One of the most useful incentives for ESID is joint participation by producers and coordinators of environmental management in technical assistance programmes that would include the dissemination of information on the existing stock of technologies, the implications of their use and the gains producers can obtain by opting for non-aggressive technologies geared to ESID.

3. Environmental quality indicators

106. The utilization of environmental indicators has considerable influence on the positions taken by society with regard to these issues and on the decisions made by politicians and producers. Indicators must be presented to society in the form of benchmarks clearly showing the desired standard of environmental quality.

107. When data on environmental quality are disseminated, together with interpretations of them, awareness of problems is increased. Society starts

to demand that public institutions take the action required to tackle environmental problems. Such social behaviour will eventually enable the public to monitor the situation, verify whether the expected results are being obtained, and demand changes if they are not.

108. To quote from the 1989 Economic Comission for Europe report for WCED, "In Canada, considerable progress has been made in collecting and integrating environmental, economic, health and biomedical data. Work is currently under way to develop a concise set of environmental indicators. France, with its patrimony accounting system, and Norway, are two cases where resource accounting has been developed. In Portugal, an experimental matrix on natural resource consumption is presently being elaborated. Decision makers in the Byelorussian Soviet Socialist Republic, at the local and enterprise level, use indices showing the extent to which natural resources and primary raw materials are used. Many ECE countries are already publishing surveys, or will do so in the near future, on environmental data. In certain countries, at the enterprise level, environmental concern systems include resource accounting as part of a so-called environmental compliance audit. The audits have recently been advocated by the International Chamber of Commerce." 7/ The Commission on the Environment of the European Communities is also currently discussing the desirability of requiring all companies to perform annual environmental audits.

4. Improvements in the decision-making process and environmental impact assessment

109. The idea of planning corresponds to the idea of a system, i.e. the need to set objectives and recognize the interaction between environment, economic policies, political policies, energy policies and spatial-organization policies. This interaction is fundamental in the context of ESID strategies. With regard to the strictly environmental aspect, however, the planning approach requires clearly defined objectives, the technical, human, financial and legal resources for attaining these objectives and, equally important, the means to measure and evaluate results, so that a critical analysis of the strategy adopted can be performed, followed by any necessary corrections. It is equally indispensable to realize that environmental decision-making processes will only be improved if the professionals working in this field are adequately trained. Otherwise, even with excellent strategies, implementation and evaluation will be deficient.

110. One of the means of improving the decision-making process is through environmental impact assessment (EIA), which is a formal study process used to predict the environmental consequences of a proposed major development project. EIA concentrates on problems, conflicts or natural resource constraints that could affect the viability of a project. It also examines how the project might cause harm to people, their homeland or their livelihoods, or to other nearby developments. After predicting potential problems, EIA identifies measures to minimize the problems and outlines ways of improving the project's suitability for its proposed environment offering options to the decision makers.

111. According to the 1989 ECE report for WCED, "EIA is considered as the instrument par excellence for integrating environmental considerations into development planning. Having been used for many years, EIA is now compulsory in many cases when new projects with possible environmental impact are under consideration. However, in certain cases, some Governments consider that the scientific level of EIA studies needs to be greatly improved." 7/ A post-facto evaluation should be undertaken.

112. EIA could play an important role at various levels of the planning process or in the process of strategy and policy formulation. So far a number of methods at the plant/enterprise level are available. The environmental impact should, however, be assessed alsc at the subsectoral and sectoral level at the stage of the formulation of development strategies and policies. In the comparison between alternative policy options the environmental impact should also play its role. Adequate methods for EIA at these levels must be applied. Without this step ESID will not be achieved.

5. Technological capabilities

113. Taking effective action to protect the environment and manage pollution presupposes the acquisition of technical knowledge, the mastery of technology and the creation of adequate operational conditions. To ensure the existence of these conditions, specific development programmes must be set up, such as technical training programmes (short on-the-job courses, both local and international, specific consultancy and traineeships) and programmes to develop capabilities in laboratory work, environmental monitoring and management.

114. The search for energy-efficient pollution reduction and clean technology can be advanced through an ambitious R and D programme, including national and international scientific and technological exchange. This programme corresponds to the adoption of an innovative strategy and the engagement of research institutes, university and R and D laboratories in developing ESID. These actions will create real conditions for a stronger institutional framework, since they provide better grounds for establishing and applying regulatory mechanisms, and a more solid foundation for the decision-making process.

E. Government initiatives and the external context

115. The trans-boundary nature of many environmental problems and the financial resources needed to solve them necessitate some form of international cooperation. Such mechanisms can vary in kind, from international environmental funds and regional development funds to external debt conversion, subsidies and grants, tradeable licenses and consumption rights. It is worth raising two issues common to these mechanisms and relevant to the possibility of promoting ESID.

116. The first has to do with the international distribution of the costs of environmental damages. The second is related to the fact that a large part of the environmental deterioration in the developing countries is an effect of their dual internal structures, wherein a majority of the population is under the poverty line. In these cases, it is necessary to discuss the political possibility of reducing such dualities by reorganizing and restructuring the economy.

117. The issue of international cooperation between Governments as well as between other actors is analysed in detail in Working Paper V entitled "International cooperation for environmentally sustainable industrial development". It is therefore not further treated in the present paper.

F. Preliminary evaluation of government instruments

118. The pros and cons of the various government intervention instruments reviewed above are discussed in this section. Whereas the polluter-pays

principle may be considered as a general guide for developing environmental policies and for the use of policy instruments, it does not provide precise specifications for the choice of policy instruments in specific contexts. Examples of additional criteria for evaluating policy instruments are as follows:

> "(a) Cost effectiveness: An instrument is cost effective if it results in achieving environmental policy goals at the lowest possible socio-economic costs. These costs can be direct costs linked to purification, costs of altering production or administrative costs linked to the implementation of the policy measures;
>
> "(b) Management effectiveness: An instrument has a high degree of managerial effectiveness if it can achieve the stated goals with a high degree of certainty;
>
> "(c) Impact on incentives for technological development;
>
> "(d) Impact on other development and economic objectives (growth, equity, industry competitiveness etc.)." 8/

119. A summary of the relative advantages and disadvantages of the regulatory approach vis-à-vis the economic incentives approach for application in developing countries, keeping in mind the above criteria, is presented below.

120. Environmental regulations in developing countries have often been replicated from past regulations in developed countries, and have consequently not been tailored to local reality. Among the problems connected with the use of regulatory mechanisms are the following:

(a) Excess cost of achieving environmental quality objectives;

(b) Excessive cost of inspection and control to government agencies;

(c) Non-compliance in monitoring and enforcement of regulation, budgetary, labour force and administrative constraints;

(d) Traditional approaches to pollution management have tended to focus separately on air, water and soil pollution at the macro level, without considering the total emissions from each plant or factory, resulting in the shifting of pollutant loading from one media to another.

121. The latter problem is being addressed in Sweden and in the United States, by the use of a new regulatory tool known as "integrated permitting" and waste minimization audits that encourage pollution prevention and adoption of clean technologies rather than pollution control. The Blackstone Project in Massachussetts, United States, attempts to coordinate and integrate the permits for air, water and hazardous waste emissions and to develop regulatory procedures for treating industrial facilities as whole entities. The project also re-examines the existing enforcement regulations with a view to encouraging the adoption of toxic use reduction initiatives by State authorities and industrial firms. 9/

122. Sweden has adopted the cross-media integrated permitting approach whereby the type of industry. its location, level of technology, type and

amount of pollution generated and their environmental impact determine the pollution parameters and emission standards. This approach allows local, regional and national authorities to impose flexible standards for each plant. An integrated permitting mechanism, as described above, along with requirements for conducting waste-minimization audits for each corporation could induce industry to adopt pollution-prevention modes of production, rather than end-of-pipe pollution-control techniques. 10/ However, it tends to be resource-intensive.

123. Another area for improvement in regulatory regimes is to allow for more negotiation between the Government and the regulated community. This negotiation, sometimes called regulatory roundtables, allows for an open constructive dialogue. 2/ In most cases, the pollutant reduction standards emerging from these roundtables will be less stringent than the Government might have wanted. The advantage is that whatever is agreed to can probably be implemented and there will be some environmental improvement.

124. One such example is an effort to control tannery waste near Madras, India. In response to new national and state legislation, tanneries and the local government worked together to establish a central waste-treatment facility for a few dozen tanneries. The central facility recovers and properly disposes of chromium salt from the tannery wastewater. In this case, industry pays 75 per cent of the costs and government pays the other 25 per cent. 2/

125. In spite of its inherent drawbacks, the reasons for using the regulatory mechanism may be sought, for example, in their apparent equality, in ethical arguments or in greater certainty for decision makers as to their impact. Another advantage that regulations have over economic incentives is that regulatory costs, including costs of compliance, loss of output and distortions, are less obvious to consumers and taxpayers and therefore are not so much in the public eye. 6/

126. Unlike the regulatory mechanism, the economic incentives approach potentially "brings environmental resources into the market and 'prices' them at a level that reflects their true scarcity and the opportunity costs of their use". 6/ As such, the associated costs are more apparent. However, as was pointed out in an earlier section, in general, improved use of economic incentives can result in a better allocation of resources, economic growth and environmental conservation, as well as increased investment in human capital and technological development.

127. Not all types of market-based policy instruments are efficient or cost effective, however. A case in point is that of subsidies or tax write-offs for the adoption of so-called "clean technologies" or the construction of waste-treatment facilities. "They do not make waste treatment or waste reduction any more profitable; they simply subsidize the producers and consumers of the products of these industries ... Tax breaks, credits, depreciation allowances and subsidies are a drain on the government budget and [can be] a disincentive to industries which might have otherwise developed more efficient methods for reducing emissions." 6/

128. The benefits of tradeable pollution permits or emission rights have been discussed above. Despite its merits, the system has so far not been applied in developing countries. One reason is that a workable system of the setting of charges requires a level of fine tuning that may become prohibitively

costly for Governments. "Ideally, charges for destructive use of the environment should be set equal to the damage or external cost that these activities generate. In practice, it is very difficult to estimate the full extent of environmental damage because they are widespread, often not easily quantifiable and take a long time to accumulate." 6/ In spite of the inherent difficulties, the advantages of emission charges over direct regulation favours its usage since they "minimize the costs of pollution control by leaving the level of individual pollution control and the choice of technology to the polluter ... Enforcement is easier and simpler because charges require no knowledge of the production and abatement technologies of different industries and no bargaining; the incentive structure facing the polluter is such that it promotes self-enforcement." 6/

129. According to the OECD Progress Report "Economic incentives have proved useful in raising revenue but in most cases have not been successful in changing behaviour or stimulating innovation". 4/ This conclusion, however, needs to be treated with some caution as economic incentives have a longer gestation period and take time to work since they are aimed at altering behaviour patterns.

130. In conclusion, the experience of Governments in this field is still at an early stage. It appears that the relative merits and demerits of using regulatory tools and economic incentives warrant a judicious mix of the two types of instrument, depending upon the nature and extent of environmental degradation being addressed. In reality the two mechanisms must co-exist along with some of the other measures outlined above.

IV. PROPOSED GOVERNMENT MEASURES AND POLICIES TO PROMOTE ENVIRONMENTALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

131. Underdevelopment and constraints on the process of economic growth represent the main causes of environmental deterioration in developing countries. Worsening economic and social indicators, accentuated in recent years by constrained foreign trade and capital balances, have forced countries to adopt strict measures, leading to reduced economic growth, as well as adverse environmental consequences manifest in reduced investments in sanitation, health and transportation facilities; declining housing standards; the occupation of areas subject to mudslides and flooding; the destruction of water sources; urban congestion etc.

132. Industrialized countries were the first to take steps to adopt regulatory and economic mechanisms for ESID. Political parties, non-governmental organizations concerned with environmental issues, business corporations, and consumers' organizations are taking active measures to promote environmental priorities. In spite of the general applicability of some of these experiences and the global approach to the management of the ESID process, it should be emphasized that developing countries face specific problems that could have an impact on their opportunities to adopt measures similar to those of the developed countries. The implementation of principles of action, which may be common to all countries regardless of their stage of development, would necessitate adaptation to differences between sectors and should respect the dual characteristics of society in economic and industrial spheres. Cultural and religious heterogeneity still exerts considerable influence on governmental decision-making in developing countries. However, an appreciation of sustainable development will be instrumental in the specification of details

necessary for the formulation of industrial strategies and policies conducive to sustainable development.

133. The implementation of an ESID programme depends on a number of factors directly connected to national Governments and the country's socio-economic structure. Some of the elements are as follows:

(a) The acceptance, by society, of the environmental component as a development factor; and by firms, of the importance of environmental issues;

(b) The need for political decisiveness by the executive branch;

(c) The existence of qualified professional staff;

(d) The technological and operating potential of environmental agencies;

(e) The interaction of the executive branch with the legislative and the judiciary;

(f) The level of organization and action by interest groups in society.

134. The extent to which the above conditions are prevelant in developing countries has implications for the nature and emphasis of the industrial strategy that needs to be adopted. In general, however, it is recognized that ESID should focus on the following policy areas/options:

(a) General industrial policies and strategies utilizing an appropriate mix of policy instruments to foster sustainable industrial development;

(b) Institutional strengthening;

(c) Training and human-resource development;

(d) Technology policy.

135. The following sections will elaborate on these policy areas with recommendations on proposed actions of a general nature. A set of guiding principles that may be applied when formulating ecologically sustainable industrial development strategies may be outlined. Not all of these principles may be relevant to all countries but the list could perhaps serve as a starting point for a discussion on country/sector specific ESID policies. The following principles are suggested:

(a) Promotion of economic growth with equity giving priority to poverty alleviation;

(b) Employment generation and creation of entrepreneurial opportunities for future generations, including adequate attention to the role and employment of women in achieving a better balance between economic, social and environmental concerns;

(c) Ambient-quality targets attained by minimum costs, adherence to the polluter-pays principle and by maintaining the competitiveness between industries;

(d) An evolutionary transition to environmentally sound economic development i.e a gradually phased shift from high polluting to non-polluting industries and technologies.

A. General industrial policies

136. General industrial policies based for example on market integration, enhancement of the productive performance and industrial automation need not all be incompatible with ESID. What is required is that in their general economic and industrial policy, Governments must choose instruments that are compatible with achieving ESID. Some reasons why ESID oriented policies need not be an obstacle to economic and industrial growth or that industrial growth need not necessarily be a threat to the environment are as follows:

(a) Industrial development creates the resources required for maintaining and improving the environment;

(b) ESID-type technologies, new technologies and environment-friendly industrial structures are often more cost-effective and productive than others;

(c) More and more environmental awareness will impose standards and regulations on products in international trade. Those who start early will have a comparative advantage;

(d) The market for products to meet ESID requirements is a dynamic and booming one presenting good opportunities for early entrants. New, often small-scale, growth industries in the "environmental" area can be created.

137. In designing their policies, Governments will, in all likelihood, have to find a mixture between regulatory and economic mechanisms while strengthening the institutional mechanism. No guidelines can be given for how this mixture should be put together. However, Governments should undertake the following:

(a) Clearly define policy objectives, goals and targets for specific industrial subsectors integrating environmental objectives in long-term and medium-term strategic plans;

(b) Analyse existing industrial plans from an environmental angle, i.e. conducting an assessment of the environmental consequences of existing sectoral plans;

(c) Formulate alternative development scenarios at the subsectoral level that would take into account growth, efficiency, equity and ecological sustainability;

(d) Assess existing environmental laws, standards and the regulatory framework;

(e) Assess existing fiscal and economic policies, their impact on the environment, industrial competitiveness and growth of the subsector;

(f) Assess, based on the above and in coordination with the private sector, non-governmental organizations and other interest groups, and devise a strategy for the use of appropriate policy instruments that would lead to ESID.

138. These policies can be implemented by the use of appropriate instruments. The review made in chapter III can give a first indication of the various instruments that are available. However, the choice of an adequate mix of instruments must be made judiciously. As was pointed out above, instruments that have a proven positive impact on the environment may not be appropriate for all countries, for example due to lack of institutional infrastructure to enforce or monitor the measure in question. The environmental impact of a measure or a set of measures must be balanced against the impact on other government objectives.

139. It is a general belief that environmental regulation is biased against new technology in favour of the status quo. 11/ Typically, control works against new sources of technology and new products whereas old ones are tolerated. By using standards based on the best available technologies, for instance pollution prevention and minimization of waste, this could be avoided. On balance, OECD concludes that regulatory regimes potentially may lead to serious efficiency losses. The cost of distorted incentives may have a long-run impact on technological development and on economic growth.

140. It is also generally believed that economic incentives send clear signals through the price system: resources use and allocation will be optimized. Industry should be given incentives to use low and new waste technologies (clean technologies) including resource recovery, recycling and reuse. The incentives should be accompanied by innovative regulatory tools such as cross-media integrated permitting and waste minimization audits. As mentioned earlier, these tools are currently being introduced in Sweden and the United States (Blackstone Project in Massachussetts). The integrated permitting approach allows the imposition of flexible standards for each industrial facility based on total emission, for instance air, water and hazardous wastes. If these permits are accompanied by suitable fiscal measures, it would fall within the framework of the polluter-pays principle and ensure that industry adopts pollution prevention and waste minimization measures.

141. Governments should further explore the use of fiscal measures, such as a carbon tax, to promote energy efficiency and reduce carbon dioxide emissions.

142. Even though the largest, most immediate improvements in pollution management often emanate from large facilities, governments of developing countries also need to devote special attention to the pollution problems of small- and medium-scale industries. These industries are usually the ones for which it may not be financially feasible, at least in the short term, to invest in pollution-control mechanisms. Governments must intervene to shape the market to reward and promote environmentally friendly economic activity. Concessional financing, special credit lines and guarantee schemes for environmental-control projects as well as the setting up of common-treatment facilities for relocation to industrial-growth estates are some of the measures that may be devised.

143. Industrial location is another policy area that can result in a more meaningful use and allocation of resources. Industries, identified on the basis of locational comparative advantage, should be located to reduce congestion and pollution and also to provide employment opportunities in lagging areas. This may be done by a proper mix of policies, including the development of infrastructure and investment promotion.

144. Although the use of economic incentives and market mechanisms are acknowledged to be more efficient in principle, their evaluation is not unequivocal. Economic mechanisms may take longer to have an impact and the impact may not be so clear cut. They are sometimes perceived as less equitable than regulation for either industry or the tax payer. What is important is that the Government must have at its disposal a wide and flexible range of policy instruments so that the best combination can be selected for each set of circumstances and each set of objectives. 4/

B. Institutional and public-awareness policies

145. One of the priorities of Governments should be to strengthen the capacity of institutions charged with formulating and implementing a policy of ESID. It is essential that these institutions play a central role and are able to assert authority over the sectoral departments. Among others, such a policy should include:

(a) Ensuring capacities for assessing the impact on the environment of various industrial development options at the national and regional levels as well as at the subsectoral and plant levels throughout industry;

(b) The mobilization of various sectors of society and public opinion in support of ESID. The main actors to be considered are society as a whole, Governments and firms. Among the latter, multinational corporations have a key role to play by facilitating the transfer of technology needed for environmental protection. The dissemination of environment quality indicators by the Government, and the requirements for undertaking environmental audits by corporate enterprises are some of the measures that may be used to mobilize public opinion;

(c) Collection and dissemination of information on production techniques and technologies, the implications and environmental impact of their use including the gains to producers by adopting environmentally friendly techniques;

(d) Establishment of management and monitoring programmes for toxic and hazardous substances and wastes;

(e) Establishment of a decentralized and coordinated decision-making system with linkages between the national, regional and local planning levels;

(f) Ensuring capacities for prevention of industrial accidents by risk-assessment procedures, safety measures and materials-handling procedures;

(g) Development of infrastructure facilities geared towards waste minimization and disposal, recycling and reuse;

(h) Establishment of a monitoring system for the enforcement of regulations.

C. Technology policy

146. Dealing with the increasing pressures on natural resources without jeopardizing economic growth requires an increase in the resource efficiency of production, which in turn implies that technological transformation must be one of the primary strategies for developing countries. "Technological

transformation means widespread, continuing development and adoption of ever less polluting and more resource efficient products, processes and services." 11/

147. The barriers to technological change are very often embedded in social, economic and cultural factors and not necessariiy in technical constraints. The structure of public and corporate policies must be reformulated to overcome these constraints.

148. Apart from the use of innovative regulatory tools and economic incentives to promote and encourage technological change, many of which have been discussed above, specific technology policies need to be adopted by Governments. Technology policy can be defined as "government actions intended to promote the development and diffusion of new technology ... a [government] policy for technological transformation should not concentrate on technologies of immediate commercial significance. Making money from new technologies should be left to the private firms. What government can do effectively ... is to support the technical areas on which commercial technology will be based." 11/

149. The range of mechanisms that can be applied includes R and D tax credits for giving incentives to industrial research; government-supported research consortia encouraging national and international technological exchange; programmes to develop capabilities in laboratory work, environmental monitoring and management; technical training programmes; technology transfer programmes that disseminate technologies from government laboratories to the private sector; government procurement etc.

150. Government procurement has been cited by the World Resources Institute as having the potential for becoming an effective mechanism for promoting environmental technologies. In the United States, procurement by the Defense Department has been one of the main means of creating markets for new technology. However, the procurement of environmentally sound technologies by the Government - purchases of recycled goods, solar-power application, and energy-efficient lighting - has so far been limited even in the developed countries. 11/ Given the extensive government purchase programmes in some developing countries, this policy has enormous potential for the promotion and development of environmental technology.

151. Research and development is another area where Governments can play a lead role, on its own and in joint activities with industry. National research in alternative energy sources; in material-separation technologies to improve the cost effectiveness of recycling low-valued wastes into high-valued goods; in new and improved electronics, optics, motors, engines etc. would not only improve industrial competitiveness but also influence the environmental performance of the manufacturing sector. Governments should also devote more attention to the analysis of positive and negative impacts of new technologies e.g. biotechnology, information technology and advanced materials.

152. The policy framework for international technology transfer is another key area that could have significant impact on the adoption of a sound environmental technology. In this respect, policies relating to the promotion of direct foreign investment, joint ventures, turnkey projects and the operation of multinational corporations would be instrumental in determining the types of technology that are transferred to developing countries. Many of these issues are being addressed also in current international efforts to implement new agreements to counteract depletion of the ozone in the upper atmosphere.

153. Further research is also needed for policy analysis that would explore innovative and well-articulated policy proposals to address the new global contexts. The design of regulatory standards and impact-assessment techniques have to be re-evaluated and experimental proposals utilizing some of the economic instruments reviewed in chapter III, above, should be formulated. Research of this nature should form a cornerstone of the technology policy in developing countries and should be supported by universities, research institutes, Governments and private enterprises.

154. This is the third of the three case-studies. It has been chosen to illustrate the need for an ESID strategy in Pakistan.

Case-study three*

155. Large-scale manufacturing industries in Pakistan are largely responsible for the discharge of toxic and hazardous wastes. Some examples of this are the effluents of the leather industry containing sodium sulphide and chromium pigments; toxic chemicals and dyes in the water discharged from textile mills etc. In addition, small-scale industrial units, located in densely populated areas often discharge their emissions into neighbouring ponds or sewage canals. Current industrial policies, the tariff structure in particular, do not address the problem adequately. The high priority given to chemicals, tanneries and metal products industries and the high effective rates of tariff protection for these industries could worsen the pollution problem unless appropriate action is taken. "Relaxed standards" for waste disposal were to be implemented in 1990, to be followed by more stringent ones. However, many industries are not even aware of these standards. Recycling or treatment of wastes is not a common practice and the attitudes of industrialists is quite negative in this respect. Factory owners do not have adequate incentives to adopt such practices given that there are as yet no functional laws on pollution control or waste-management services. Moreover, industrialists do not have an idea of the relative costs and benefits of installing pollution prevention mechanisms.

156. As noted in the Asian Development Bank study, "if the deteriorating situation is not dealt with soon, the eventual cost to reverse and repair the damage could be tremendous and far more than a developing country like Pakistan can afford. The situation demands immediate intervention". A number of immediate steps are recommended in the study, including:

(a) The operationalization of the institutional set-up dealing with industrial pollution prevention, in particular, and the updating and implementation of the existing Pakistan Environmental Protection Ordinance of 1983;

(b) The setting of realistic standards on wastes, the formation of a waste management body to deal with the treatment and disposal of industrial effluents, solid wastes and toxics;

(c) The establishment of obligatory environmental impact assessments (EIA) for all projects to be cleared by the Government, and of a database system on environmental pollution monitoring this, along with EIA would form the basis for decision making with regard to alternative policies for ecologically sustainable industrial development;

*Based on Economic Policies for Sustainable Development (Asian Development Bank, 1990), pp. 184-186.

(d) The strengthening of existing R and D institutions concerned with environmental pollution. R and D efforts should concentrate on the adaptation of technology, clean technologies, in-service training to industrialists etc.;

(e) Financial incentives to industry for waste treatment and pollution reduction.

D. Development policy for human resources

157. As mentioned earlier, competent human resources have a key role to play in reconciling economic and ecological objectives. Environmental education, in the long run, can steer the response of technology and industrial policy towards sustainable development. The Governments in developing countries can supplement economic incentives by playing an important part in the process, through both the formal and informal education systems.

158. Formal education, through various tiers of the school and university system, should attempt to incorporate and integrate environmental sciences, regulation and design into the existing curricula of course work It has been argued that excessive emphasis on specific disciplines, such as ecology or separate environmental engineering courses, should be replaced by a multi-disciplinary approach so that environmental factors complement traditional disciplines and do not appear as an afterthought in the education system.

159. Governments may also devise programmes of informal education via the mass media, public hearings of environmental impact reports, political parties, business organizations etc.

V. RECOMMENDATIONS

160. Governments should integrate ESID more effectively into international, national and local planning for industrial development by:

(a) Building considerations of environment and sustainable development into economic planning activities at the policy and operational levels;

(b) Revising current legal and institutional mechanisms as needed, to achieve a better balance of regulatory and economic measures that will promote ESID and to eliminate or minimize existing measures that are counterproductive;

(c) Actively encouraging ESID through research, development, acquisition, and transfer of new technologies, as well as more rapid and efficient utilization of existing relevant technologies in the public and private sectors, and through public/private partnerships;

(d) Promoting technical and management training and education that incorporates ESID into a broad range of disciplines at the university and professional levels;

(e) Promoting ESID through environmental education and participation by the general public and interested non-governmental organizations, such as corporations, employees, consumers and environmental organizations;

(f) Cooperating in international efforts to achieve ESID;

(g) Supporting exchanges of information and experience on ESID among developing countries, as well as between developing and industrialized countries.

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INTERNATIONAL COOPERATION IN ACHIEVING ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

Working Paper No. V

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CONTENTS

Annexes

INTRODUCTION

1. The focus of this paper is on ecologically sustainable industrial development (ESID) in developing countries and the potential role of international cooperation to achieve ESID.

2. The period following the Second World War has seen a tremendous growth in industrial activity. As the Brundtland report pointed out, 25 years ago the world was manufacturing one seventh of the goods it manufactures today and was extracting one third of the minerals. This pace of industrialization has had serious effects on the environment and on the global natural resource base.

3. Conversely, industrialization has brought with it many benefits in terms of improved economic growth and most developing countries are eager to accelerate their processes of industrialization, even though this historically has resulted in higher environmental degradation.* Though its share of total industrial output is still quite low, it is expected to rise to 15 per cent of total world industrial output by the end of the century. 1/ Furthermore, developing countries are expected to continue to gain a larger share of the "smokestack" industries as tighter environmental standards in the industrialized nations given a comparative advantage to developing countries with less stringent environmental controls. UNIDO estimates that during the period 1980-1985, the manufacturing value added (MVA) of 15 traditional industries generally regarded as heavy polluters (e.g iron and steel, industrial chemicals, footwear, petroleum refineries) grew at least twice as fast in the South as in the North.

A. What is ESID?

4. Whereas the exact definition of sustainability will probably continue to be debated for some time to come, in this paper, the "strong" definition discussed in Working Paper I is accepted. This definition emphasizes the non-substitutability of certain environmental resources and the maintenance of an adequate, or threshold, level of environmental resource endowments, in particular, those that are essential to supporting life on Earth.

5. The practical manifestation of ESID is ultimately in the specific actions and behaviours of individual enterprises. This is the "bottom line" for ESID, that firms in developing countries implement manufacturing, R and D, design

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*Furthermore, there are indications that the rate of environmental degradation is higher than that of industrialization. For example, in the case of hazardous waste generation, Hirschhorn and Oldenburg find that, when highly industrialized, medium-income and developing countries are compared, an increase of 25 times in gross national product (GNP) per capita is accompanied by an increase of 150 times in per capita hazardous waste generation. They also note that the big increase in hazardous waste generation occurs in the early stages of industrialization. See Joel S. Hirschhorn and Kirsten U. Oldenburg, Prosperity without Pollution (New York, Van Nostrand Reinhold, 1991).

and overall management strategies based on the principles of environmental sustainability. Factors both internal and external to the firm can influence such behaviour. Internal factors such as management style, skill sets, "corporate culture", motivation, technological "intelligence", business goals and profit and market-share considerations clearly can only be addressed through direct action by the management and ownership of the firm. In this sense, the orientation of firm-level action towards ESID will depend ultimately on the extent to which environmental soundness and business profitability are seen to coincide.

6. The external factors include national and international policies and contexts that impact upon industry, the general business climate and infrastructure and relevant socio-political conditions.

7. The internal factors are discussed in Working Paper III, and Working Paper IV analyses the role of Governments in promoting ESID. This paper examines the international dimension.

B. The international dimension

8. The international dimension is of critical importance for the achievement of ESID in these respects:

(a) Financial resources: The mobilization of financial resources is vital to ESID, as it is to the environmental problem in general, and international sources of financing, particularly the Development Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development (OECD), play a positive role. Two key issues here have to do with the mobilization of additional resources and the linking of financial support with environmentally sound industrial development. Also important is an examination of the variety of potential sources for financing, both public and private, that could be mobilized for ESID;

(b) Technology: A key to successful ESID is what the World Resources Institute refers to as "technological transformation": the development, transfer and utilization of environmentally sound technologies ("clean" technologies) by industrial firms. A great portion of these technologies and the related technological capabilities reside in industrialized countries and corporations based in those countries. Furthermore, specific issues involved in technology acquisition, such as intellectual property rights, involve international negotiations and cooperation. On another level, international collaboration is an important mechanism for technology development. For example the Consultative Group on International Agricultural Research (CGIAR) has been very successful in agricultural research, and the Eureka Programme for collaborative research by European countries may also offer some useful guidelines. International technology cooperation along South-South lines may also be important for ESID by enabling the sharing of experiences, resources and capabilities for mutually beneficial purposes. Tighter standards, as in the European Community, can provide an incentive for improvements but can also adversely affect the competitive advantage of products from those countries. The entire issue of environmental standards is complex and sensitive;

(c) International trade: There is increasing concern over the linkages between trade and environment, both in terms of how trade policies may impact adversely on environmental concerns, and in terms of how environmentally sound action may cause distortions in trade patterns. Issues relating to protectionist policies, product and process standards and specifications, foreign direct investment flows, structural change etc. need to be addressed at the international level. Developing countries' exports to industrialized nations may suffer adversely as result of stricter environmental standards and regulations.

9. In all these areas - financing, technology and trade - both developing and developed countries need to take proactive stands based on a sensible assessment of the environmental problem and its implications at the global, regional and national levels. The effects of industrial activity are experienced at these levels and responses also need to be at these levels, depending on the nature of the problem and the resources available.

10. For example, ozone layer depletion and the greenhouse effect are problems of a global nature, though they originate in local activities such as the use of chloro-fluoroarbons (CFCs) and industrial pollution. The pollution of lakes and rivers is often a problem at the regional level, but it also has a strong local component. Solid waste disposal and recycling are issues of primarily a local nature, but the issues of transborder flows of toxic waste and the need for R and D to improve recycling technologies are such that they lend themselves to global action.

11. The form of response is also a function of how specific the problem is. The Montreal Protocol on Substances that Deplete the Ozone Layer addresses a very specific issue on which there is general agreement and is a global response to a problem that needs to be addressed at the local level through reduced use and production of CFCs. In other cases, especially where the main effects are felt locally, local initiatives and commitments are essential. The involvement and commitment of both the public and private sectors at the local level become important in this respect.

12. International cooperation can play an effective role at all these levels. The Global Environment Facility (GEF), for example, aims at supporting local environmental problems that can alleviate global problems. Environmental problems such as desertification, water pollution, acid precipitation and air pollution lend themselves to regional cooperation. Some problems, such as improved recycling programmes, industrial pollution control and waste treatment, need to be addressed at the local level, though international cooperation can play an important role.

C. The need for a strategic approach for UNIDO

13. All of this entails international cooperation of both a North-South and South-South nature. Within this context, an appropriate role and programme need to be defined for UNIDO which build on its strengths and constitute a logical extension of its capabilities and experiences for the promotion of ESID. In particular, UNIDO's status as an international organization, its years of experience in industrial development in developing countries, its extensive network of experts and field offices, and its role within the United Nations, which gives it the mandate for industry, should be the foundation for its approach to and involvement in ESID.

14. A strategic approach of addressing ESID issues should be a priority of technical cooperation. For example, the industrial rehabilitation programme of UNIDO can result in both economic gains and environmentally positive results. Assisting developing country firms in attaining certain environmental standards can help them to become more competitive in international markets and to overcome environment-based tariff and non-tariff barriers.

15. A strategic approach for UNIDO activities with respect to ESID must be built upon an assessment of UNIDO's particular strengths and capabilities, a realistic appraisal of the demand for ESID-related services and assistance, the resources available, and the particular "niche" where UNIDO can have the most impact. Building on existing programmes would be a wiser strategy than creating totally new programmes.

16. The rest of this paper is devoted to an analysis of the financial, trade and technology issues and concludes with a set of recommendations on international cooperation for achieving ESID and the potential role of UNIDO.

I. FINANCIAL SOURCES, FLOWS AND REQUIREMENTS

17. A key question for ESID is the extent to which the financial resources are available and needed to achieve the desired goals and with the appropriate mechanisms for mobilizing and deploying those financial resources. Unfortunately, this is precisely an area where there is very little information of any systematic nature, and the best that can be done is to make rough approximations based on whatever is available. DAC is presently attempting to compile statistics on environment-related development assistance, but there are apparently problems due to the reporting procedures used by DAC members.

A. Potential sources of financing

18. The first issue has to do with the current financial flows and resources directed to ESID, or potentially available for ESID, and the extent of the needs.

19. While it is not possible to estimate the total financial resources that would be needed for ESID with any degree of accuracy, the amount is likely to be quite large, and it is useful to examine the sources from where these resources might come.

20. DAC is one major source, and there is a clear case to be made for additional resources from the development assistance community. Within DAC, increasing portions of bilateral official development assistance (ODA) are being directed to environmental projects. For 1990, the United States Agency for International Development (USAID), for example, increased its financing for environmental protection to 22 per cent, which amounts to $368 million for this fiscal year (compared to $287 million for the previous year). 2/

21. At present only 5.5 per cent of official ODA is designated for industry and this figure has been declining in recent years.

22. Developing country Governments themselves should be another source, on the order of about 1 per cent of gross domestic product (GDP) for environmental purposes broadly defined, as has been suggested by the Economic Commission for Latin America and the Caribbean (ECLAC) and by the World Resources Institute.

23. Private sector investments in ESID-related projects will make a positive contribution, but only if the economic environments in developing countries make such investments attractive either through appropriate policy measures or other inducements. However, there are many examples in industrialized countries of pollution prevention projects that have been implemented with payback periods ranging from a month to three years. 3/ This last scenario is an ideal win/win case, since such technological improvements would also enhance the competitiveness of those industries. Several large corporations in industrialized countries are making their own investments in environmental technology and programmes, and an ECLAC report entitled "Sustainable development: changing production patterns, social equity and the environment" (LC/G.1648(CON.80/2)), cites several Latin American corporations which have implemented environment-oriented programmes.

24. Revenues generated by fines and fees levied on industry based on a "polluter-pays principle", added foreign investment resulting from relaxed investment codes and relaxed profit repatriation policies for environmentally sound projects could also be included in the calculations of financial resources available for ESID.

25. Debt for nature swaps, an additional source, has been used to a limited extent for conservation projects. The external debt of developing countries is about $1,000 billion. A modest portion of this debt, if converted for ESID purposes, could make a significant contribution.

26. Redirection of military expenditures, currently estimated at $270 billion per year for the developing world, could also result in additional resources.

27. Manufacturing productivity improvements can also release resources for ESID while improving productivity. Advances in computerized controls for manufacturing, chemical catalysts and process engineering which improve industrial productivity also enhance environmental efficiency.

28. The rapidly emerging environment industry offers entrepreneurs the opportunity to profit by developing capabilities in it. The estimated market for such goods and services was $200 billion in 1990, and the industry is expected to grow at a rate of 5.5 per cent per year over the next decade. New manufacturing techniques such as chemical vapour deposition (CVD) can yield significant environmental benefits. Even incremental improvements in recycling processes or waste collection and processing can offer a source of business opportunity while also contributing to environmental priorities.

B. Financial requirements

29. On the demand side, institutes such as Worldwatch have estimated that between $10 billion and $40 billion per year will be needed for environmental purposes over the next ten years. It is not clear how much of this will be for ESID, however, these figures being based on broad "guesstimates" that mainly serve to indicate the magnitude of the need.

30. At a more specific level, a recent study on Thailand estimates that the cost of treatment of hazardous waste from all industries except basic metals would be of the order of 600 million baht annually, or 0.3 per cent of the annual GDP produced by those industries. For biodegradable waste, the estimate is 1 per cent of their annual GDP or 361 million baht for achieving 70 per cent treatment of the current level of biochemical-oxygen-demand (BOD). However, it is important to note that in countries such as Thailand, structural change in industry is leading to new types of pollution problems associated with high technology industries, where the clean-up costs can be considerably higher and where the environmental implications are not well understood.

31. In the industrialized countries, studies show that the pollution abatement costs (PAC) for the heaviest polluting industrial sectors range from 1.92 to 2.89 per cent of total output cost. 4/

II. OVERVIEW OF DEVELOPMENT ASSISTANCE COMMITTEE APPROACHES TO ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

32. In broad terms, the development assistance agencies in the industrialized countries have begun to give increased attention to environmental concerns in the design of their assistance programmes. The Development Assistance Committee (DAC) of OECD has issued guidelines for assessing the environmental impact of assistance projects and has called for an increased commitment by member countries to assist developing countries in reducing poverty and controlling population growth.

33. Although it is evident that concern within the donor community for improving the environmental soundness of projects is increasing, there is less evidence to indicate that a common understanding is emerging of what environmental improvement actually means. Improved cooperation between DAC members, the United Nations, the World Bank and other assistance agencies will require a common understanding of the relationship between environmental protection and industrial development, and the means by which both can be achieved simultaneously.

34. In this regard, several issues crucial to ESID have yet to be resolved or even addressed by the international community.* There is no code of conduct for multinational corporations to guide them in their foreign investment decisions, in spite of the continuing efforts of the United Nations Centre for Transnational Corporations (UNCTC); no global mechanism for monitoring the use

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*Though, in some cases, efforts are under way, e.g. the Centre for Transnational Corporations Code of Conduct, the Basel Convention, standard-setting in the European Economic Community (EEC), the Guidelines for Business established by the International Chamber of Commerce.

and disposal of toxic exports, in spite of the Basel Convention on the Control and Transboundary Movements of Hazardous Wastes and Their Disposal; no consistent regulation of high-risk technology transfers, and no mechanism to facilitate the harmonization of national environmental standards for products and processes.

35. UNIDO, given its mandate on industry, could play a special role in contributing to the establishment of common guidelines and principles for ESID among the various organizations involved.

A. Bilaterals

36. DAC members are currently developing a common policy orientation, harmonizing the environmental impact assessment (EIA) of aid-supported projects, and exploring ways to address environmental issues for each industrial sector that receives assistance. There is also general agreement on three basic components in aid policy as it affects the environment. These are described below.

1. The need for additional projects that have as their primary purpose the upgrading and rehabilitation of the environment to improve long-term economic growth and sustainable development

37. New programmes have apparently increased rapidly in recent years, but most of them deal with forestry and soil conservation and greatly resemble projects that were once categorized as "rural development". It is not yet clear whether these projects actually represent new initiatives, or whether they are simply a reclassification. Genuine "additionality" will require a net increase in total assistance funds available to developing countries in their pursuit of ESID. The critical lack of capital in most developing countries does not permit a net gain in environmental sustainability without a real increase in assistance programmes and investments.

38. As the objectives of environmental protection and industrial development begin to converge under the heading of "sustainable development", the issue of additionality may become less central. Additional funds for ESID are required only to the extent that ESID is distinguished from other forms of industrial assistance. The development of more and cheaper clean production technologies, and the improved availability of these products for developing country firms, will narrow the gap and reduce the need for additional funds to prevent environmental damaging resulting from industrial activity.

2. Measures to strengthen the ability of developing countries to deal with environmental issues

39. This raises the related question of a policy dialogue and technical support in which both donors and recipients assume certain obligations. Development assistance agencies and banks that provide ESID-related resources for developing countries in need of capital would discuss with recipients, for example, how emissions can be kept below a certain threshold in industries receiving funds.

40. But it is also important to realize that "strings" attached to funding significantly increase the complexity of negotiating for funding and that conditions agreed upon between developing countries and outside funding sources are less likely to become internalized within the local society.

41. Furthermore, bilateral aid has in the past been tied to the purchase of donor country goods and services, which can result in the export of technologies not best suited for the recipient country's environmental needs.

3. Environmental impact assessment procedures that can be incorporated into traditional development projects

42. All DAC members have adopted some form of EIA for assistance projects and are in various stages of establishing institutional structures to carry them out. Some have identified a particular point in the project design process where the environmental impact is formally assessed. Others have chosen to treat the environment as a cross-cutting issue requiring input at all stages of project appraisal. In the case of the former, environmental offices or departments have been established within the agency bureaucracy. In the latter, individuals with environmental impact expertise have been placed throughout the organizations.

43. As of this writing, eleven DAC members have established formal procedures for implementing EIAs for their activities. Others are currently designing procedures. There is increasing harmony among the emerging approaches. Procedures generally involve an initial screening of projects to identify those that have the potential to impact the environment. However, there is some divergence in the criteria used to determine such impact. If the potential for impact is significant, there is an initial environmental examination of the project to determine whether a more extensive EIA is necessary. If an EIA is conducted, the project must incorporate measures to decrease environmental impact and procedures for monitoring impact must be included.

44. OECD, in its 1985 Council recommendation on environmental assessment of development assistance projects and programmes, recommends EIA for projects that involve: substantial change in renewable resource use, i.e. converting land to agricultural use, or forest into pasture land; changes in farming or fishing practices; infrastructure; industrial activity, particularly extractive industry; and waste management and disposal.

45. The DAC members that have not yet established formal guidelines intend to use these guidelines as a model. But even among those members that have formalized procedures, experience in implementing them remains very limited.

46. The analysis of development assistance agencies in the OECD countries does not reveal a significant increase in projects that are designed specifically to promote ESID. Rather, the trend is toward preventing negative environmental impact from projects that are otherwise as close to conventional as possible.

B. Multilaterals and financing institutions*

47. By the nature of their organization, multilateral agencies such as the United Nations, the World Bank and the regional banks provide a focal point for the development of international cooperation strategies to promote ESID. Following are brief descriptions of the relevant activities of several of these groups.

1. United Nations Environment Programme

48. UNEP was established in 1972 to coordinate the environmental activities of the United Nations in environmental assessment, management and support measures. Initiatives in these areas are based in the UNEP Earthwatch programmes, which include the Global Environment Monitoring Systems and the Global Resource Information Database (GEMS/GRID), which coordinate activities of other monitoring systems and fill gaps as needed; INFOTERRA, a database of environmental information from around the world; and the International Register of Potentially Toxic Chemicals (IRPTC), which supplies information on potentially hazardous chemicals to local authorities responsible for environmental protection and public health.

49. In natural resource management, UNEP provides expertise in the planning and design of United Nations development activities that may impact a developing country's natural resource base and assists countries in developing responsible standards and regulations. For industry, UNEP provides a variety of services through its Industry and Environment Office.

50. UNEP also has a library to promote environmental education and has training programmes to assist policy makers in analysing the environmental consequences of various public policy alternatives. Since 1980, UNEP has been assisting several multilaterals in developing environmental criteria and procedures for assistance projects.

2. United Nations Development Programme

51. UNDP initiatives are aimed at developing and implementing a holistic environmental approach to development. UNDP has cooperative arrangements with several Governments and organizations. With the World Meteorological Organization, UNDP has developed monitoring systems to assist countries and regions in assessing climate change and air quality. The joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) has been promoting the use of natural gas as an energy source instead of coal or hydrocarbons. This initiative has significance for ESID not only because natural gas burns more cleanly, but because considerable but underused gas reserves exist in many developing countries.

52. In addition to these initiatives, UNDP provides many training programmes and basic technical assistance to developing countries, including country-specific workshops. In 1990 UNDP introduced the Sustainable Development Network (SDN), in which all 113 field offices coordinate the promotion and management of environmental programmes.

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*This section draws heavily on the DAC 1990 Report (Organisation for Economic Co-operation and Development, 1990) and World Resources Institute, Natural Endowments: Financing Resource Conservation for Development (Washington, D.C., 1989).

53. Annex I contains more details on the role of UNDP in the environmental area.

3. World Bank

54. The World Bank established in 1987 an environment department and four regional environment divisions to promote environmental activities within the Bank. About one third of the Bank's loans in 1989 were for projects that had environmental concerns built in. The Bank is also conducting in-depth studies of key environmental issues on a continuing basis, including country-specific action plans which include suggestions for Governments. Several of these plans are currently under way, including environmental policy development, investment strategies and criteria for prioritization.

55. The Bank has also instituted codified procedures for environmental assessment to screen projects with potential environmental effects and to enhance borrowers' capabilities to deal with environmental issues, often through institution-building.

56. Annex II describes environmental activities of the regional development banks.

C. Limitations of current approaches

57. As the above descriptions indicate, multilateral and bilateral agencies have been treating the environment as a special, high priority issue for only a few years in most cases. Very few projects now being implemented have ESID as their primary objective. Rather, sustainability is being incorporated into projects through EIA, conditionality structures that promote clean technology use, reductions in population relocation requirements etc. The projects themselves, however, continue to be categorized under traditional industrial development headings. It is therefore difficult to measure financial flows specifically for ESID.

58. It also appears that little attention is paid to indirect environmental effects that may result from training and education projects, even though it is clear that the information communicated to individuals in the public and private sectors of developing countries regarding the management of public utilities and production facilities can have a significant impact, either positive or negative, on the environment. USAID categorically exempts all training projects from any form of EIA. The World Bank requires some form of environmental assessment for all water supply and sewerage projects, but not for public sector management projects.

III. GLOBAL INITIATIVES

A. Global Environment Facility

59. Established by the World Bank, UNEP and UNDP in 1990, the Global Environment Facility (GEF) is designed to fund programmes that locally address ozone depletion, greenhouse gas emissions, biodiversity and international waters. The objective of GEF is to assist Governments in developing cost-effective ways to address these issues, and to develop institutional capabilities for such programmes. In this endeavour, UNEP will provide overall policy guidance and act as a clearing-house. UNDP will be responsible for operations at the country and

regional levels of the technical assistance and pre-investment phases, the World Bank for capital investment activities. GEF will also provide a framework for providing operational experience in funding environmental aspects of development and for complementary financing arrangements with non-governmental organizations (NGOs), entrepreneurs, bilateral and multilateral agencies and Governments

B. Montreal Protocol on Substances that Deplete the Ozone Layer

60. Researchers first reported their concerns about the effect of CFCs on the ozone layer in the early 1970s. Widespread publicity in the industrialized countries led to public boycotts of aerosol products that used CFCs as a propellent, leading to a ban on such usage in Canada, Sweden and the United States of America in 1978. For ten years, however, the ban did not spread and aerosol propellent remains the single greatest use of CFCs in the world today. In fact, new uses for the chemical has pushed global CFC usage back above 1977 levels, even in countries with the aerosol ban. In 1984, the Natural Resources Defense Council, a United States-based NGO, filed suit against the United States Government for not conforming to regulatory process. In response, major CFC producers intensified their efforts to find alternative chemicals. Building on earlier initiatives, in 1987 the developed and developing countries adopted in the Montreal Protocol a programme of heavy cuts in the use of CFCs. The Protocol came into force on schedule in January 1989 and was subsequently amended in 1990 in the light of new scientific evidence of the acceleration of ozone depletion. The amended Montreal Protocol calls for the complete phasing out of fully halogenated CFCs by the year 2000; halons (used in fire fighting), except for essential uses; carbon tetrachloride by the year 2000; and methyl chloroform by the year 2005. With the announcement by China in June 1991 at the Third Meeting of the Contracting Parties that it would ratify the Protocol, provisions for funding reached $200 million over a three-year interim period to help developing countries meet their obligations under the Protocol.

61. The Interim Multilateral Fund for the Implementation of the Montreal Protocol is administered from within GEF. It is an example of the linkage between environmental and developmental concerns, developed and developing countries, and the public and private sector, that can be achieved under the rubric of "sustainability". The Conference for the adoption of the Montreal Protocol resulted in an international agreement on an ambitious timetable to reduce CFC emissions and provided an additional flow of funds from the donor community to developing countries. The recipient countries agreed to make important concessions in terms of their rate of increase of CFC usage.

62. While it is still too early to realistically assess the performance of GEF or the Multilateral Fund, there are high hopes within the assistance community that such mechanisms will succeed in addressing key global environmental problems. Other initiatives, such as the Basel Convention, are also seen as models for future efforts to deal with global environmental protection. However, it is important to note that the Basel Convention only occurred in response to a major toxic waste spill, and that the timetable and funding mechanism established by the parties to the Montreal Protocol to reduce CFC emissions were a response to an especially pressing environmental crisis - the development of a hole in the ozone layer and the related risk of global warming. In the case of the Montreal Protocol, the problem addressed was very specific and unambiguous, limited to a single chemical, and the production of CFCs was limited to a handful of companies. It remains to be

seen whether similar agreements can be reached in cases where the exact sources of environmental damage are not known, where they are much more numerous and spread throughout the world, or where the problems are largely of a local nature.

IV. COOPERATION BETWEEN DEVELOPING COUNTRIES

63. Information flows in the developing world tend to be predominantly North-South rather than South-South. Developing countries have very limited information on other developing countries, their institutions, products or capabilities. However, there has been significant development in many of these countries in recent years, to the point where cooperation between them could have a meaningful impact on development generally and on ESTD in particular.

64. Economic and technical cooperation in developing countries has been a priority for many years. Arising from a common perception of the causes and solutions to the problems of economic development, political consensus among developing countries led to many commmon positions on international development issues. Two groups, the Non-Aligned Movement and the Group of 77, represent the most durable, noteworthy, and the broadest expressions of this cooperation. At another level, regional and subregional groupings have been developed that address the need for closer cooperation in economic and technical terms and, increasingly, direct their efforts towards common markets, preferential trade areas, and customs unions, with the objective of full economic union being increasingly espoused.

65. Significant recent developments in this field at the interregional level, include the General System of Tariff Preference (GSTP), which was agreed in 1989 by 48 member countries of the Group of 77. It covers the mutual reduction of all trade control measures (TCMs) affecting trade by the member countries. Virtually all developing countries with a high international trade volume are signatories. The agreement will enter into force once it has been ratified by 15 States.

66. A further new development at the interregional level is the formation in 1989 of the Summit Level Group of Developing Countries, also known as the Group of 15. It includes both the non-aligned and other developing countries, especially the larger and more industrialized States, with representation from different regions. At its first Head of State-level summit meeting, held in Kuala Lumpur in June 1990, it adopted a wide-ranging statement dealing with many areas in which cooperation would be addressed in practical terms by its members. It stressed the need to recognize the special position of the developing countries in the formulation of international initiatives on the environment:

> "Any global initiative in overcoming environmental problems required concerted international co-operation based on an equitable sharing of responsibilities which takes into account existing asymmetries between developed and developing countries.

Developing countries require substantial additional resources for pursuing their goals of sustainable development, including access to environmentally sound technology at affordable cost and the establishment of funding mechanisms. The Group recognizes the importance of co-ordinating our positions on issues of major concern to us on the agenda of the forthcoming UN Conference on Environment and Development to be held in Brazil in 1992."

67. The Group of 15 summit meeting approved a number of specific projects, with the assignment of responsibility to individual countries for coordination and implementation. They include new mechanisms for environmental cooperation based on the new impetus for ECDC and TCDC provided by the Group of 15. The adopted proposal for a South Investment, Trade and Technological Data Exchange Centre (SITDEC) to promote and disseminate information on investment and trade opportunities in the South and on technologies and transfer of technology among developing countries is of special importance.

68. The environmental considerations in trade and technology transfer discussed in this paper would find a useful reflection in the activities of such a Centre. It may also be pointed out that several of the other projects accepted in principle at the Summit included several of directive relevance to ESID, including the establishment of a gene bank among developing countries, and the semi-industrial fabrication of small solar refrigerators. On wider macro-economic concerns which affect ESID possibilities, the participants also agreed to set up a meeting of financial experts on external debt and an advisory group to assist the developing countries in their dealings with multilateral financial institutions on issues of debt and loans.

69. The Summit also agreed to establish a second round of negotiations in relation to the GSTP. This could incorporate specific discussions of ESID issues, especially those related to standards and to technical requirements, quality control and the need to encourage reciprocity and harmonization in international trade, with special reference to ESID and, increasingly, in trade in environmental goods and services.

70. The environmental issue was also dealt with explicitly at a ministerial Conference of developing countries on environmental development, which was held in Beijing, 18 to 19 June 1991. The Conference adopted the Beijing Ministerial Declaration on Environment and Development. One issue raised was that of resources for developing countries to achieve the protection of the environment. A Green Fund was proposed to address problems, such as water and coastal pollution, shortage and degradation of fresh water resources, deforestation, soil loss, land degradation, and desertification, not covered by specific international agreements. It would also cover the costs of the transfering environmentally sound technologies and enhancing national capabilities for environmental protection and scientific and technological research. For other areas of environmental concern, where specific agreements were adopted internationally, the Declaration called for financial support to cover the requirements of developing countries in fulfilling their commitments.

71. Given the commitment to South-South co-operation, and the now considerable institutional framework that has been set up, there are certainly prospects for increased co-operation among developing countries in ESID-related areas. However, the complexity of the issues and considerable geographical dispersion of developing countries means that the best prospects for South-South co-operation in this field will probably be found at the regional and sub-regional level. Organizations which have as their goal the specific integration of the member states due to their geographical proximity and common perception of development goals, are the vehicles most likely to be able to absorb ESID-related activities. The Preferential Trade Area for Eastern and Southern African States (PTA), for instance, included ESID-related projects as part of a wider package of industrial projects. The PTA itself has moved from its initial phase as an organization for the encouragement of free trade among its member states to begin implementing a full programme of economic integration, including the formulation of an integrated industrial programme.

V. TRANSNATIONALS AND PRIVATE CORPORATIONS

72. As sources of a great wealth of information on the use of hazardous materials, environmental management techniques, pollution abatement equipment and cleaner production technologies, and as major producers of environmentally damaging products, by-products and activities, private corporations, more specifically transnational corporations, will be expected to play a major role in the transition to ESID.*

73. Several initiatives have been taken to establish guidelines for corporations with regard to the environment, including UNEP's environmental guidelines, the International Chamber of Commerce environmental guidelines, OECD guidelines on multinational enterprises, the Chemical Manufacturers Association's Responsible CARE programme and the United Nations Centre on Transnational Corporations' Criteria for Sustainable Development Management. (E/C.10/1990/10 Annex I, 11 January 1990).

74. UNCTC has isolated five main areas in which transnational corporations (TNCs) can promote environmental protection without sacrificing development:

(a) Supporting international agreements, laws and policies covering environmental issues;

(b) Contributing to the development of effective means for transferring environmentally sound technologies to developing countries;

(c) Developing and implementing global management strategies that integrate environmental concerns in the economic development process;

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*For a more detailed discussion on the role of transnational corporations in achieving sustainable development, see Peter Hansen, "Criteria for sustainable development management of transnational corporations", UNEP Industry and Environment, July-December 1989, and "Transnational corporations and issues relating to the environment: the contribution of the commission and UNCTC to the work of the preparatory committee for the United Nations Conference on Environment and Development", Commission on Transnational Corporations, February 1991.

(d) Education and training for employees to increase environmental awareness throughout the organization and in communities to support the analysis and monitoring of the environmental situation, and to improve the ability of responsible individuals to anticipate environmental risks;

(e) Identifying and providing additional financial resources to expand expertise and technological capability for ESID in developing countries.

75. UNCTC has proposed that TNCs establish an environment fund, to be managed by a United Nations-affiliated financial intermediary, to include voluntary corporate contributions, a for-profit venture capital fund and a for-profit mutual equity fund, with a view to financing environmental projects in developing countries. The proposal is currently on hold due to budgetary constraints.

76. Existing barriers to the transfer of environmentally sound technologies to developing countries include: lack of incentive for TNCs to sell such technologies to developing countries due to their small internal markets, lack of environmental laws in developing countries requiring sound technologies, and the higher cost of these technologies compared to those "polluting" technologies now in place in developing countries.

77. UNCTC has conducted a study entitled "Transnational corporations and industrial hazards disclosure", to identify ways in which developing countries could benefit from the experiences of industrialized countries. Disclosure requirements regarding possible risks to public health, safety and the environment of TNC activities in developing countries is considered one of the most important issues related to TNCs in developing countries. Such disclosures would allow developing country Governments to make more informed decisions about allowing TNC investments, and information on disclosure requirements in industrialized countries would make it possible for such Governments to hold a TNC accountable for risks that exceed those in its country of origin.

78. In 1990, the Intergovernmental Working Group of Experts on International Standards of Accounting and Reporting began considering the issue of information disclosure on corporate environmental measures. The Group made suggestions for standardizing environmental auditing relating to both qualitative and quantitative information. As follow-up, UNCTC has begun a project on accounting and reporting standards for sustainable development, which deals with current practices regarding environmental information disclosure by TNCs and seeks to improve techniques for measuring environmental costs and liabilities. The project will also attempt to develop a valuation methodology for determining unreported social costs of non-sustainable industrial activity and to develop internationally comparable standards for environmental auditing by TNCs.

79. Reducing the damage to the ozone layer from CFCs is the most successful example to date of international efforts to protect the global environment. As a result of compelling scientific evidence and persistent public pressure, the Vienna Convention and the Montreal Protocol have achieved broad consensus among Governments in the industrialized world, and companies, confronted with the impending threat of strict regulation, have dramatically increased their commitment to the environment and self-regulation. Private and public sector research into reducing the need for CFCs and internally initiated phase-out programmes are becoming common. Many companies have pledged to meet the Montreal Protocol targets ahead of phase-out schedules.

80. Almost all CFCs are produced by a handful of large chemical companies in OECD countries. One such company alone accounts for 25 per cent of world supply. TNCs are also the dominant buyers of CFCs, especially those that produce air conditioners, refrigerators and electronic products.

81. Although TNCs were initially opposed to CFC regulations of any kind, the position of many of them is that, since restrictions are unavoidable, international regulation that puts all competitors on the same footing is better than a confusing mix of country-specific laws.

82. Several TNCs, including ICI and Rhone Poulenc, have announced their intention to produce HFC134a, an alternative to CFC. Major CFC buyers are moving cautiously toward these alternatives because the switchover is expensive and there are questions about the requirements to redesign products that will be competitive. IBM and Digital Equipment, which use CFCs as solvents to clean electronic parts, have begun to use CFC-free processes for some cleaning operations.

83. Although there is still a long way to go before CFCs are eliminated, the progress achieved to date is a useful example of how Governments, NGOs, business and the public interact to reform industrial practices to protect the environment.

84. Annex III describes in more detail the role of TNCs in global environmental concerns.

VI. ROLE OF INDUSTRY, TRADE, PROFESSIONAL, SCIENTIFIC AND ENGINEERING ASSOCIATIONS

85. Industry, trade and scientific organizations can play a major role in assisting developing countries and small- and medium-sized companies to employ ecologically sustainable technologies and processes and to purchase and produce environmentally sound products. These organizations provide a valuable forum for the exchange of information and the establishment of industry-wide codes of conduct.

86. The extremely high level of activity among trade associations, research and policy organizations etc. is a strong indication of the far-reaching implications of ESID. Although many of the industrial organizations focus on the needs of transnational corporations and developed country companies, many are specifically targeting the needs of developing countries.

87. The International Chamber of Commerce (ICC), as previously mentioned, has developed environmental guidelines for world industry (see annex IV). Through its International Environmental Bureau (IEB), ICC provides technical information sharing on environmental issues to the developing world and seeks to generalize the best existing practices of their members to the business community at large. The World Environment Center (WEC) is directly involved in technology transfer, training, and institutional and factory assessments in the developing world through its International Environment and Development Services. WEC's International Environment Forum, whose membership includes 57 multinational corporations, encourages the inter-sectoral exchange of information and experience and provides assistance in international environmental management and environmental auditing.

88. Many trade and professional associations are taking a leadership role in addressing environmental issues. The International Federation of Consulting Engineers, a federation of national associations of independent consulting engineers, has an environmental mandate designed to enhance professional environmental services and formulate codes of professional conduct. The American Institute of Architects in the United States is currently producing an Environmental Resource Guide, the Chemical Manufacturers Association has its aggressive responsible CARE programme, and the National Association of Manufacturers is currently preparing a seminar on pollution control and energy exports to Eastern Europe and the third world.

89. ESID-related conferences, programmes, mandates and publications are being initiated by the International Council of Scientific Unions (ICSU), the International Institute for Advanced Systems Analysis (IIASA), the Commonwealth Consultative Group for Technology Management (CCGTM), and the Club of Rome, to name a few. In addition, new organizations such as the Global Environmental Management Initiative (GEMI), the International Institute for Sustainable Development (IISD) in Winnipeg, Canada, and the Business Council on Sustainable Development in Geneva are currently in the early stages of their development.

VII. TECHNOLOGICAL CHANGE, TRANSFER, ACCESS AND DEVELOPMENT

90. "Technological transformation", a term coined by the World Resources Institute, is the key to ESID. In the face of increased population pressures, and the continuing need for rapid economic growth, the only viable option to reduce the environmental impacts of economic development is through the development, diffusion and utilization of increasingly efficient and environmentally sound technologies. Such a goal requires international cooperation on an unprecedented scale.

91. Many of the technologies needed to reduce environmental problems exist in industrialized countries; often, they are profitable as well. There is also growing consensus on the need for "clean" technologies rather than "end-of-pipe" solutions. Advances in high technology - microelectronics, biotechnology, advanced materials, energy technologies - further enhance the potential for achieving ESID.

92. On the other hand, there are major changes occurring in the global context of manufacturing itself that have important implications, both positive and negative, for ESID.

A. The changing context for international technology cooperation

1. The major changes taking place in the global marketplace

93. Major changes are generating a variety of pressures and opportunities for firms wishing to compete in this market. Put another way, the goal of achieving ESID must be pursued with due regard to the fact that firms also need to be competitive in the world economy and that nations need to foster such competitiveness among their firms. A firm can be environmentally sound, but this does not in and of itself ensure its competitive success. In fact, many of the initiatives to improve the competitiveness of industrial firms in developing countries may have unintended negative environmental consequences.

2. The new techno-economic paradigm

94. Industry is undergoing fundamental restructuring around the world and a new techno-economic paradigm is emerging based on new forms of manufacturing, competition, inter-firm linkages, market dynamics and the possibilities opened up by technological advances, particularly in the area of informatics and information-based technologies.

95. Global economic growth is slowing and there is a rise of regional trading blocs (e.g the European Community, North America); commodity prices are falling in most instances and there is an increase in protectionist trade policies.

96 As noted in the ECLAC report prepared for the Latin American and Caribbean regional preparatory meeting for the UNCED, held in March 1991 in Mexico City, "international markets are now clearly in the process of globalization and regionalization. This process has been set into motion by a notable decrease in communications and transport costs, by the ability of some nations to incorporate technological progress and to disseminate it through their system of production, by entrepreneurship and by the incorporation of additional countries, particularly countries in South-East Asia, into the international market" (LC/G.1648(CON.80/2), p. 90).

3. Comparative advantage based on the availability of natural resources is declining

97. Developing countries are therefore increasingly being faced with the challenge presented by a new paradigm and the simultaneous erosion of the basis for their traditional comparative advantages. New forms of competitive behaviour, which enable developing countries to capture key market niches based on their own strengths and to capture a greater portion of the value-added chain are called for, though it is as yet unclear as to whether this is a feasible option for some countries, given their heavy debt burden, weak infrastructure, shortage of human technical skills and lack of access to technology.

4. New principles of efficiency

98. The capabilities a firm needs to become globally competitive are being redefined in ways that offer both challenges and opportunities for ESID. Emerging principles of efficiency such as Just-in-Time, Zero Defect, Total Quality Management and Concurrent Engineering have created financial incentives to reduce waste, improve equipment maintenance and process efficiencies and decrease energy consumption - all of which go hand in hand with the goals of ESID. Common to all these new approaches is a "process focus" which emphasizes continuous improvement throughout the manufacturing process. This is what distinguishes an ESID approach from an "end-of-pipe" approach, where the problem is treated after it has occurred. In this sense, the basic assumptions and beliefs underlying the new efficiency principles for manufacturing are very close to those underlying ESID.

99. In many industries, a new efficiency principle - economy of scope - is emerging to replace economies of scale as the essential means of reducing production costs and enhancing flexibility and responsiveness to market demand.

100. In the industrialized nations, small technologically sophisticated firms are producing more jobs than the manufacturing giants and are becoming increasingly important as sources of innovation and suppliers to larger firms. For many developing countries, the small- and medium-scale sector similarly holds the potential for enhanced job creation.

5. Technological "multipolarity"

101. On another level, technology is proliferating and sources of technical innovation are expanding rapidly. The United States, once the leader in technological innovation, is now sharing this position with other advanced countries such as France, Germany and Japan and other OECD nations. New technologies are also being developed in the newly industrializing countries or areas, and some Eastern European countries, such as Czechoslovakia, Poland and Yugoslavia are also becoming suppliers of technology.

102. At the same time, firms are becoming more aggressive in seeking proper "rents" for their technological know-how, and as such, access to these technologies by developing country firms has not become easier simply as a result of technological "multipolarity" (the proliferation of potential sources of technology). This in turn is reflected in the ongoing debates over international technology transfer and access to technology and the increasing need for mechanisms to facilitate the monitoring, assessment and sourcing of technologies on an international scale by developing countries. However, it is not only a question of the latest technologies. Many of the needed technologies are already available:

> "Theoretically, technology now on the shelf could solve these problems. The resources devoted to these efforts, however, are minuscule in comparison to the need. A massive effort to transfer technology from developed to developing countries could contribute more than any other action to environmental sustainability". 5/

6. Intellectual property rights

103. Intellectual property is already a growing issue within the environment context. On the one hand, it is argued that access to environmentally sound technology is essential if developing countries are to achieve ESID. However, the developers of these technologies, in many cases TNCs, seek to receive adequate "rents" for their investments in these technologies - and thus demand appropriate protection of their intellectual property. This translates itself into high costs for acquiring these technologies by developing countries, most of which are already saddled by heavy debt burdens, lack of foreign exchange and poor negotiating capabilities. Add to this the general weakness of technological capabilities in developing countries and the lack of good information on available technologies.

104. The international property rights (IPR) aspect of ESID is beginning to be addressed in various fora. For example, UNEP, in cooperation with the World Intellectual Property Organization (WIPO), organized a meeting of experts to discuss the role of intellectual property in technology transfer within the context of the Montreal Protocol. 6/ Particular emphasis was given to the potential role of compulsory licensing, while noting that Governments did not have the power to compel industry to market products internally or internationally.

B. Access and demand assessment

105. Even where there is a recognition for the need for sustainable industrial activity, the lack of information about alternatives in terms of inputs, technologies and processes remains a barrier for most developing country firms. Improved availability of information on environmentally sound options and alternatives is essential to the achievement of ESID in developing countries, with an emphasis on practical and proven information and technology. In this regard, the clearinghouse role of the International Environmental Bureau in Brussels is a noteworthy initiative.

106. For UNIDO, the experiences and capabilities associated with its own databases and information systems, such as the Industrial and Technological Information Bank (INTIB) could be built upon. Information, along with practical assistance and follow-up (so that the information is used well), is essential for ESID and charts out a specific area where UNIDO can play a role.

107. UNCTC has been developing several interesting options for facilitating access to technology by developing countries. These include international environmental offset programmes, investment programmes, tradeable pollution permits, relaxation of limitations on the repatriation of income derived from environmentally sound technology, tax disincentives to restrain the use of environmentally hazardous technologies, and tariff barriers to restrict trade in environmentally hazardous technologies.

108. On the demand side, there is still little in terms of systematic assessments of the technology requirements in developing countries and there is a need to compile an inventory of technological needs in developing countries vis-à-vis ESID.

C. Policies and regulations

109. There is a need to overcome policy and regulatory barriers to technology transfer and development and to improve the technological capabilities of developing country firms so as to enhance the quality of technology transfer.

110. Environmental regulations should be developed so as to encourage long-term technological innovation and continuous improvement. The traditional focus on "best available technology" is inadequate in itself and can result in non-innovative behaviour. As stated in the World Resources Institute report:

> "Regulations have largely been uncoordinated across media (air, water, land), have focused on "end of pipe" pollution controls instead of pollution prevention options, and have provided no incentives for doing better than standards dictate" (p. ix).

111. Similarly, technology policies need to promote the development, diffusion and utilization of "clean" technologies. Innovative mechanisms such as technology incubators, university-industry linkages and technology commercialization centres could be mobilized towards ESID ends. Education policies also need to encourage a greater appreciation and understanding of the environmental aspects of technology and industry.

D. Emerging opportunities in the environmental area

112. Looking at the issue from another perspective, the growing concern with ecologically sustainable alternatives could yield specific but time-bound opportunities for developing countries. A new "environmental" industry is emerging, involving waste treatment, recycling, energy efficient alternatives, etc. This market could offer entrepreneurs in developing countries the opportunity to enter new areas of business. Every new piece of legislation aimed at controlling or preventing environmentally adverse activities leads to a demand for new goods and services. Though precise figures are not available, the United States Environmental Protection Agency (EPA) estimates that in 1985, 1.7 per cent of United States GDP was spent on environmental protection measures. In France, it was 0.9 per cent, in Germany it was 1.5 per cent and in the United Kingdom of Great Britain and Northern Ireland 1.3 per cent for the same year. The global market for environmental goods and services is expected to be around $200 billion per year and increase at a rate of 5.5 per cent per year over the coming decade.

113. Furthermore, there is an increasing number of trade shows that focus on environmental services and goods and there do not seem to be serious barriers to entry into this industry. Also, a large percentage of firms that specialize in these services are small- or medium-sized and therefore may be suitable for developing countries. In sum, while the dynamics and trends in the environmental business are still not well understood, there are good indications that there may exist specific windows of opportunity for developing countries to participate in this business.

E. Technology cooperation

114. Technology cooperation at the enterprise level is one of the most important approaches to ESID. Given that many of the needed technological resources for ESID are housed in TNCs or corporations in developed countries, and that the market for ESID-type technologies is likely to grow, not only in industrialized countries but in developing ones as well, it would serve the interests of all parties concerned to encourage and undertake technological cooperation at all levels - governmental and enterprise. In a recent paper, the International Environmental Bureau (IEB) emphasizes the importance of company-to-company cooperation for achieving ESID: 7/

> "The cooperation process should be such that both parties win - medium and long term - socially and commercially, e.g. by each helping the other to obtain access to new markets and by producing goods and services more efficiently and more sustainably. The most successful cases of technology cooperation in business and industry occur when mutual benefit by both contracting parties is maximized.
>
> "The successes of technology cooperation associated with cross-licensing arrangements, with technology-equity exchanges, with joint ventures and with strategic alliances show how emphasis should be placed upon the long term commercial and strategic strengthening of both partners rather than upon the immediate narrow financial aspects of the deal" (p. 5).

115. Cooperation at a broader level is also important, and the experiences of international technology cooperation programmes such as EUREKA should be examined for their lessons for ESID-based cooperation.

VIII. INTERNATIONAL TRADE, ENVIRONMENT AND INDUSTRIAL DEVELOPMENT

116. Trade is a relevant issue because environmental policies can result in trade distortions and trade policies can lead to environmentally negative results. As in the case of technology, this is occurring in a changing context.

A. ESID and international competitiveness

117. While concern over achieving ESID grows, this is occurring within a context of increasing emphasis on the international competitiveness of firms. As noted in the ECLAC report:

"International competitiveness based increasingly on the incorporation and dissemination of technical progress in a context in which great economic and political value is attached to ecologically sustainable development in many parts of the world will probably be one of the hallmarks of the 1990s" (LC/G.1648(CONF.80/2), p. 89).

118. The new form of competition is based on principles of continuous improvement, flexibility, customer responsiveness, total quality management and new inter-firm arrangements.* The production philosophy underlying these new principles has taken hold more firmly in the industrialized nations, though there are good reasons for developing countries to explore these new options. The Republic of Korea, for example, has made rapid advances by pursuing a mix of policy measures aimed at maximizing their competitive position in key markets and industries in the global economy. But the more general question of whether developing country firms can stand to gain by incorporating these new principles and the enabling technologies remains relatively unexplored. Viewpoints range from those who claim that the advent of the new technologies based on flexible specialization will make it more difficult for developing countries to compete - because access to technology will become more difficult, to those that emphasize the "soft" aspects of the new paradigm of competition, and claim that these new principles are within the grasp of developing countries and can yield relatively large competitive gains. 8/

119. Though developing countries recognize the need for ESID, the means of achieving it in the context of changing patterns of international competition are unclear. The traditional bases of competition for the developing countries, natural resources, cheap labour and large domestic markets, are not completely eroded and will continue to influence industrial activity in the developing countries. And for most developing countries, faced with the need for foreign exchange and burdened by large populations, external debt and declining terms of trade, the pursuit of industrialization based on their traditional sources of comparative advantage is not an option but a necessity.

B. Environmental implications of trade policies

120. Additional difficulties include: lack of access to the technologies and financing needed to undertake ESID-type activities; an international commodities market that continues to work against their interests; and a series of protectionist and regulatory barriers in the industrialized countries that hinder their capacity to develop their export potential in non-natural-resource-based industries.

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*Several authors have examined this changing pattern of competitiveness in the global economy, including Michael Piore and Charles Sabel, The Second Industrial Divide: Possibilities for Prosperity (New York, Basic Books, 1984); Carlota Perez, "Technical change, competitive restructuring and institutional reform in developing countries", World Bank, Strategic Planning Review, discussion paper No./4, December 1989; Michael H. Best, The New Competition: Institutions in Industrial Restructuring (Cambridge, Harvard University Press, 1990); and Michael E. Porter, "The competitive advantage of nations", Harvard Business Review, March-April 1990.

121. Important in this context are current patterns of structural change in world industry, which are resulting in the migration of polluting industry to the South, particularly following the world-wide stagflation of 1980-1982, which forced many developing countries to move towards high-technology industries.

122. On the other hand, there does not seem to be any empirical evidence in support of the "pollution haven" hypothesis that suggests that the higher costs of pollution abatement in the North and the weaker environmental regulations in the South encourage polluting industries to move. To further complicate the matter, in certain countries, structural change is leading to a transition from traditional pollutants associated with smoke-stark industry to mico pollutants (toxic chemicals) associated with high technology industries, i.e. semi-conductor manufacturing and biotechnology.

123. What is clear is that in the medium and long term it is in the interests of all parties concerned in the North and South to use "clean" technology in all locations and to pursue environmentally sound trade policies. Because of the uneven nature of the global trading system, however, such measures may be easier to pursue in richer countries than in poorer ones.

124. This problem is further compounded by the fact that environmental costs are not valued properly by the market because of their "public good" nature and that current trade practices do not reflect the variations in the environmental carrying capacities of different countries, their relative environmental endowments or the environmental content of their output.

125. In sum, there is no clear-cut evidence that industrial migration to developing countries is inherently "dirty", but there has been a general pattern of movement of natural resource intensive industries to the South. To address this issue, two broad sets of actions are needed:

(a) Establishment of proper accounting systems that reflect true environmental costs;

(b) Examination of investment promotion programmes, export promotion zones, structural adjustment programmes for their environmental implications.

126. Countries, and even regions within countries, vary in terms of their abilities to absorb environmental externalties, their roles as suppliers and consumers of non-renewable resources, their industrial output of polluting products and their trade policies.

127. As a medium-term objective the market mechanism should accurately reflect environmental costs and benefits so that an optimal pattern of environmentally sound international trade is achieved. In this regard, there are several trade measures that bear consideration in the international context. These are described below.

1. Tariff and non-tariff barriers

128. Tariff and non-tariff barriers, whether intentional or not, can lead to distortions in international trade with negative environmental consequences. For example, restrictions on market access (the quota system) can force countries to increase production of polluting or natural resource intensive goods because they cannot capture other product markets. Coupled with domestic and external financial problems, many developing countries did indeed resort to pollution-intensive sectors during the 1980s. Increased protectionism in the developed countries reduces market access for non-traditional goods from developing countries and hence prevents their diversification into more ecologically sustainable activities.

129. This is especially a problem with respect to process industries, resulting in the over-exploitation of natural resources for export in, for example, the timber industry. It is only recently that countries such as Thailand have taken drastic measures to curtail deforestation caused by timber exports.

2. Production and export subsidies

130. All Governments take measures to enhance the competitiveness of their goods and services in international markets through subsidies for production and export. Environmentally unsound distortions can be caused by encouraging greater production in certain sectors rather than in others which are ecologically more sound. Developed countries continue to subsidize certain sectors such as shipbuilding, mining, steel, textiles and automobiles, even though these are sectors where developing countries could develop a comparative advantage, and through the use of clean technologies, pursue a more environmentally sound alternative.

131. Despite general principles adhered to by most countries involved in GATT, subsidizing is still practised and leads to price and market distortions. These include export credits and guarantees, tied aid (conditionality) and offsets. Export supports are particularly important in such sectors as steel, transport equipment and construction, resulting in overcapacity and an uneven geographical distribution of output.

3. Trade agreements

132. Most trade agreements fail to treat the environmental factor adequately. This is true of agreements involving automobiles, steel and textiles that include voluntary export restraints and orderly marketing agreements. It is also true of free trade agreements (common markets, regional agreements etc.) where concerns have been raised about the environmental impacts of trade liberalization measures. While free trade agreements can improve the overall levels of trade, they do not automatically ensure that this is environmentally sound. In fact, they can lead to the movement of pollution-intensive industries to environmentally sensitive areas and can limit the use of economic measures for environmental management. They can also result in the weakening of environmental regulations and standards. In the case of the United States, while the "fast-track" authority sought by the President will allow for more flexibility in trade negotiations, it can also reduce the likelihood that environmental issues will be scrutinized appropriately.

133. Preferential trade agreements between developing and developed countries, for example the Generalized System of Preferences (GSP), the Lome Convention and the United States Caribbean Basin Initiative (CBI), can also divert trade in environmentally unsound directions and cause environmentally unsound structural adjustment in developing countries.

134. Finally, trade-related investment measures (TRIMs) and trade-related intellectual property rights (TRIPs) need to be assessed in terms of their environmental implications. TRIMs can impede investment in environmentally sound industrial development by discouraging foreign investment through exchange restrictions, local input requirements and profit repatriation restrictions. However, TRIMs can also be used by Governments to encourage environmentally sound investments.

135. TRIPs, similarly, can contribute to encouraging trade in environmentally sound products and technologies. IPRs are designed to encourage innovation and invention and, if properly implemented, could encourage firms to develop and market goods and technologies which are ecologically more sound. On the other hand, IPRs also increase the expense of technologies and make it more difficult for developing countries to acquire them. Corporations can play an important role in this area by taking a long-term view and allowing freer access to their technologies in return for more relaxed investment regulations by developing countries, market access etc.

C. Trade impacts of environmental policies

136. The basic issue is the trade-distorting impacts of environmental policies and regulations, which fall into three categories: regulatory instruments such as standards or norms; economic instruments such as subsidies, charges and taxes; and trade instruments such as export and import controls.

1. Regulatory instruments

137. The main issue here is that of standards, which are of four types: product-, process-, ambient- and emission-based.

138. The lack of acceptable international standards for industrial products and processes, which would enable the "benchmarking" of products and technologies on an international scale, is a complex problem. Uneven standards can lead to trade distortions and "ecoprotectionism". The issue is further complicated by the fact that most environmental standards for manufactured goods apply to the final product itself and not to the process by which it is manufactured. Environmental labelling schemes also tend to suffer from this drawback. As a result, products that prima facie are "green" can appear on the market even though the processes by which they are made have negative environmental effects.*

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*There have been some efforts, however, to address this problem. In its "Position paper on environmental labelling schemes (ELS)", the International Chamber of Commerce notes that many programmemes include labelling of products to describe appropriate use and disposal practices, emergency response procedures, control of waste disposal methods, training programmes etc.

139. Furthermore, as the OECD countries enact tighter environmental legislation, "one important consequence of this may be the already perceptible emergence of protectionist barriers raised on the assumption that other countries have failed to comply with environmental standards relating to products, manufacturing processes and raw materials" (LC/G.1648(CON.80/2), p./94).

140. Different environmental standards will be appropriate depending on a country's specific circumstances, such as the level of natural resource dependency and endowments and the efficiency of its markets. The value of harmonization, or perhaps, as suggested by the OECD, "coordination", 9/ is dependent on the issues involved in a specific situation. For example, agreement on common principles such as the "polluter pays principle" is sufficient to avoid international conflicts of interest. Other issues such as global and transfrontier pollution and toxic waste problems may require stricter policy instruments and clear-cut international standards.

141. The trade implications of environmental standards need to be discussed in fora such as GATT. Within OECD, some attention is already being given to international differences in environmental standards in such areas as automobile products and chemicals with a view to avoiding their leading to non-tariff barriers.

142. In this regard, the position of EPA, as stated in a recent report, is noteworthy:

> "Internationally accepted standards to limit the exchange and use of polluting products and technologies could clearly help to achieve the goal of global environmental protection. The Board believes that the U.S. should spearhead a movement toward the adoption of environmental standards, both health and performance based, by all nations, covering imports and exports of products, equipment and processes ... The U.S. government should also stress the need to incorporate sound environmental standards in the agenda for the next GATT round. An effective first step toward a leadership role would be the imposition of such standards on American suppliers". 10/

143. At present, there is wide disparity in standards, stemming partly from differences in industrial structures and environmental goals carrying capacities and endowments. In the developing countries, additionally, the use of standards is hampered by and access to information a lack of required skills, institutional structures.

144. Environmental labelling, discussed earlier, also needs to be standardized and harmonized. In many instances, "green product advertising and environmental labelling have developed in a frequently uncontrolled and misleading fashion". 11/

Differences in labelling schemes can be a source of distortions and problems in international trade and this is an area again where international cooperation is required. In the industrialized countries, industries which have been able to develop products that are environmentally sound or "friendly" have gained a competitive advantage in some areas. On the other hand, poor labelling of products from developing countries can have a negative impact on their attractiveness to consumers in industrialized nations. A standardized system of labelling would be an important step in overcoming such problems. In developing countries, where consumer awareness of environmental issues is generally lower and monitoring of labelling practices is weak, the effectiveness of labelling schemes may be undermined.

145. Perhaps specific guidelines for manufacturing process quality can be established, rather than set standards. The certification of these processes as "green" could be left to private organizations. Large corporations could play a useful role by requiring their overseas suppliers to adhere to certain principles of environmental soundness, much along the lines followed for quality control. In certain specific instances, minimum standards could be established, especially where hazardous or toxic waste is involved. An appropriate role for UNIDO may be to assist firms in achieving these standards and developing the capabilities to meet best operating practice guidelines.

2. Economic instruments

146. The main effect of subsidies, charges or other economic instruments are likely to be on the cost-competitiveness of firms and sectors. Subsidies for environmental purposes can cause trade distortions, a fact already recognized in OECD. Government support for pollution abatement can lower production costs and raw material costs.

147. In OECD, other forms of economic instruments are coming into increasing use: emission charges, product charges, administrative charges, deposit refund schemes, fiscal incentives etc., but the trade effects of these are still not well understood.

3. Trade instruments

148. Three types of trade instruments are being used to implement environmental policies: complementary measures, which are implemented in coordination with domestic environmental measures; coercive measures, which are used to influence environmental practices in other countries; and countervailing measures, which are used to counter environmental policies in other countries.

149. In all cases, the basic issue is the same: what is the net effect on trade of these measures? Some, such as import restrictions enforced to support domestic policies, can be both trade-distorting as well as environmentally positive. Others, such as coercive sanctions against goods from countries with unsound environmental policies, can be politically sensitive, but may be effective in the long run.

150. Not enough is known at present about the net gains from many of these measures. Needed is a deeper examination of the issues involved and their implications for ESID and the discussion of these issues in the appropriate fora.

151. These issues involve:

(a) The setting of guidelines for environmental policies, taking into account the impact on trade, the role of GATT, the points of contention ("sensitive areas") between industrialized and developing countries, the implications at the local and regional levels, and the financial implications thereof for developing countries;

(b) The use of trade instruments for environmental purposes, including such measures as complementary restrictions, coercive or countervailing measures, the multilateral use of trade, potential trade distortions and impacts on competitiveness and the potential role of GATT and other negotiating fora;

(c) The implications of trade liberalization for the environment, with a focus on where environmental and trade interests coincide and where they are in conflict, the special environmental needs of the developing countries and their focus on development and their need, in some cases, to protect domestic industry and to restrict exports.

IX. CONCLUSIONS AND RECOMMENDATIONS

152. From the foregoing discussion, it is evident that the scope for international cooperation to achieve ESID is vast and also complex. Clearly the political will to pursue environmentally sound industrial development at all levels is essential to its achievement. In addition, the proper knowledge base, institutions, infrastructure, skills, regulations and international agreements are needed in order to implement ESID strategies. The United Nations system and particularly UNIDO can play a key role in this regard, but success will depend heavily on the support and cooperation of both developing and industrialized country Governments, private corporations, the donor community and other relevant international organizations.

A. General recommendations

153. Based on the analysis presented in this paper, there are several general areas where international cooperation is needed to achieve ESID:

(a) Research on a variety of aspects of ESID, the extent of demand for and supply of "clean" technology, the economics of ESID etc;

(b) Improved flows of ESID related information, and the more effective utilization of this information so as to achieve practical results;

(c) Improved access to "clean" technology, which involves policy and company-level actions and commitments;

(d) Efforts to develop environmental standards and policies, taking into account the differences between countries in terms of environmental endowments, carrying capacities and comparative advantage;

(e) Mobilization of financial resources from a variety of traditional and non-traditional sources, and from the private sector in both developing and developed countries;

(f) The improvement of the competitiveness and productivity of developing country industry, and continued efforts to remove trade-related barriers to their participation in global markets based on true competitive advantage;

(g) Educational and training programmes to create skill sets and human capital in areas essential for the long-term success of ESID;

(h) Closer cooperation between the public and private sectors in industrialized and developing countries in ESID.

B. Proposed agenda for UNIDO

154. Given its mandate within the United Nations, its considerable experience with industrial development and with research on industry and development, its strong engineering and economics human resources and wide network of field offices and experts, and its "hands-on" approach to industrial development, certain broad parameters for an agenda for UNIDO are suggested. Absent is any great emphasis on addressing the trade-related aspects of ESID, since by and large these tend to lend themselves to international negotiations in fora that already exist (e.g. GATT). (However, UNIDO can play a role in assisting developing countries to meet the standards and requirements, and by industrial sector and branch analysis provide the necessary input to international negotiations and strategy development.)

1. Diagnostic and analytical studies

155. Efforts are needed to improve the understanding of the environmental dimension of industrial development, in terms of better information (on levels of pollution, waste etc.) and more comprehensive analyses of needs in terms of skills, technologies, finances etc. Also important is the development of generally acceptable procedures and guidelines for environmental accounting and auditing, GNP calculations which include the environmental costs and benefits of industrial activity, and improved analytical models of the linkages between the various stages of industrial activity in developing countries and broader environmental concerns.

156. Specifically, a variety of studies are required to establish a sound knowledge base upon which ESID strategies can be built:

(a) Diagnostic studies, which assess the "demand" aspect of ESID in various sectors and countries, in terms of technological, financial, human resource, intrastructural and institutional needs would be useful. These studies could be conducted for different "scenarios" of industrial development, based on different assumptions of growth, resource availability, national objectives, market conditions and technological development. Such scenarios would provide developing countries with the basis for designing and implementing appropriate industrial development strategies to achieve ESID. Such an effort would also be useful as an input into the developmental assistance programming of donor agencies;

(b) Analytical studies, which examine in-depth the implications of ESID strategies and actions for international trade and technology transfer, natural resource flows and financial flows, would be useful in improving the understanding of how ESID is likely to impact on important international issues for developing countries and would also serve as a basis for discussions in international fora such as GATT. Also important in this regard is the development of methodologies for natural resource accounting and GNP calculations that incorporate realistically the environmental costs and benefits of industrial activity. This would be valuable for making inter-country comparisons, development assistance programming and national industrial policy formulation. A complementary effort that is required is the preparation of guidelines and methods for firm-level accounting and auditing of environmental costs and benefits for use by firms in developing countries.

2. Information exchange and follow-up

157. There is a clear need to improve the quality, flow and exchange of information between countries and at the enterprise-to-enterprise level on environmentally sound technologies, management experiences, resources, skills etc., and to ensure that this information is used well.

158. UNIDO could consider joinging with key clearing-house networks such as the ones operated by UNEP/IEO, to facilitate the exchange of information on experiences of individual firms trying to improve the sustainability of their operations. Case studies focusing on technology acquisition, R and D, employee training and strategic management would be helpful to developing-country enterprises interested in reducing their environmental impact but lacking the experience needed to do so effectively. The International Environmental Bureau (IEB) of the International Chamber of Commerce, which helps small- and medium-sized businesses obtain information to improve their environmental performance, offers a useful model in this regard.

159. Important in this regard is UNIDO's own INTIB system and its broad experience with information collection and dissemination.

160. Equally important in this respect would be the development of a "follow-on" service to assist firms in making the best use of the information provided, whether it be related to technology acquisition, capacity building, training, or firm-level cooperation.

3. Mechanisms and policies for technology transfer and development

161. It is necessary to improve the terms and conditions which influence the access to environmentally sound technologies by developing countries, and to develop science and technology policies at the national and international levels which would encourage the generation and use of such technologies at the local level.

162. Trade barriers and conflicts over intellectual property rights and patent protection are impeding the flow of these technologies into the developing world, which poses a serious threat to ESID in these regions. If technologies that reduce greenhouse gases are not accessible to developing countries, the continued depletion of the ozone layer caused by industrial activity in these countries will impact the quality of life in all countries. No single country can achieve a sustainable global environment on its own, so the technological tools that promote ESID must be spread as widely as possible.

163. To promote the international flow of ESID technologies, UNIDO could play a role in cooperation and consultation with other international organizations by:

(a) Assessing firm needs in developing countries for sustainable technologies and identifying sources and emerging R and D trends in relevant technology areas. This effort should build on existing information systems such as the Network for Environmental Technology Transfer (NETT) in Brussels, which identifies potential matches between vendors and purchasers, and the International Cleaner Production Information Clearinghouse (ICPIC) at the UNEP/IEO. (Industry and Environment Office);

(b) Assessing modalities of technology transfer (i.e. joint ventures, licensing, distribution agreements) and trade policies affecting them (i.e. intellectual property rights, tariffs and patent protection) for their implications for ESID, and providing advice to member States and enterprises in these areas;

(c) Assisting developing countries in a review of technology policies, with an emphasis on guidelines and criteria for ESID technology development, and improved integration of science and technology policies with other national policies, particularly those that foster industrial development;

(d) Identifying the financial, scientific and human resource requirements for the domestic generation and utilization of ESID technologies in developing countries and taking initiatives for international technology development for ESID, for example, a system of R and D institutes possibly modelled on the CGIAR system for agricultural research;

(e) Initiating dialogue with TNCs about prospects for technology transfer to developing countries, factors impeding such transfers and steps that could be taken to alleviate barriers.

4. Assisting member States in achieving international environmental norms standards

164. Wide variations now exist in the product standards and specifications of different countries. To some extent this is inevitable, given the unique circumstances of each country in terms of economic development and international trade relations. However, because of the inherently transnational nature of the environment, and therefore of ESID, standards that relate directly to environmental products need to be harmonized to some degree

to permit the widest possible distribution of environmentally sound products and processes. Currently, clean technologies developed in one country have limited application in many other countries, in part because of variations in standards and the rapid rate at which they are changing. This limits the market for such technologies, which in turn reduces the incentive for firms to invest in the R and D required to improve the environmental soundness of industrial products and processes. Firms making transnational purchases of clean technologies are often forced to make extensive modifications, which places developing country firms with limited technological capability at a disadvantage.

165. UNIDO already works closely with Governments and firms to assist them developing national standards and quality capabilities, as well as in improving product and process quality so as to come closer to internationally agreed upon standards. Such technical assistance will, if it takes fully into account the emerging trend toward environmental regulation, prove invaluable to many developing countries.

5. Financial mechanisms

166. UNIDO can play a useful role in the identification of innovative mechanisms to improve the level and quality of financial resources available for ESID-oriented development.

167. Innovative financing mechanisms such as eco-venture capital funds and other innovative mechanisms to encourage the growth of an "ESID supply sector" and to provide financial resources for ESID projects and programmes could be promoted by UNIDO. Much of the technological and managerial changes that promote ESID in firms present profitable business opportunities for small- and medium-sized local suppliers, particularly those capable of providing custom equipment. Mechanisms such as the Nordic Environmental Financing Corporation (NEFCO), which serves as a source of venture capital for the financing of joint ventures between Nordic and East European companies, and the World Resources Institute's "Ecovest" concept, should be studied for their relevance to developing countries. The Trust Fund mechanism operated by UNIDO also promotes a flexible mechanism by which funds may be channeled for development at the firm level. Again, UNIDO's investment promotion activities, including investment fora and the Investment Promotion Services, could be utilized to mobilize finance for such ventures.

6. Identification of key areas of opportunity for developing country industries

168. The global concern with environmental issues could conceivably offer some "windows of opportunity" for developing the emerging international market for environmental goods and services. UNIDO could play a useful role in identifying those specific areas or "niches" where developing countries may have a competitive advantage (e.g. in certain parts of the materials or product loops referred to in Working Paper I, in activities that are inherently labour-intensive, or small-scale in nature) and assist developing countries in taking advantage of these opportunities. This again would build on UNIDO's extensive experience in pre-investment studies, including opportunity studies and pre-feasibility studies, as well as wider sectoral studies at the national and international levels.

7. Training and education

169. The success of ESID will depend heavily on the availability of the proper sets of skills at all levels. Efforts are therefore needed to develop technical and managerial skills in developing countries through training programmes, changes in curricula in schools, vocational training institutes and universities and the development of educational materials for dissemination to industry. Executive seminars designed to show industrialists the business benefits that can be derived from environmentally sound activities would be particularly useful on topics such as Environmental Auditing, Environmental Quality Management, Technology Acquisition and Licensing etc. The training aspect of UNIDO's existing work on feasibility studies and on technology acquisition are already significant, and the new activities could build on them.

8. A dynamic public: private partnership for ESID

170. The active involvement of the private sector, including both small and large enterprises, is essential to ESID. Efforts are needed to develop dynamic mechanisms that promote the participation of the private sector in ESID efforts of Governments and international agencies.

171. UNIDO could contribute in this area by taking the initiative, perhaps in collaboration with other organizations such as the ICC.

172. A specific initiative may be the development of industry liaison mechanisms to engage industrialists in dialogue with governmental officials at the policy level. The strengthening of relevant national industry associations through training, technical assistance and financial support for improving their capacity to promote environmental concerns among their memberships is another potential role for UNIDO.

9. Promoting industrial efficiency

173. Underlying all of these suggested recommendations, however, the importance of efforts to improve the efficiency, broadly defined, of industrial activity in developing countries must always be recognized. Enhanced productivity and efficiency and balanced industrial development in developing countries is a principle that must be followed in order to achieve ESID and equitable growth in the long term. The contributions of new management techniques and "soft" technologies for productivity enhancement within the context of ESID need to be more fully explored. In this regard, the activities of organizations such as the Global Environmental Management Initiative (GEMI), with its focus on applying Total Quality Management principles to environmental management, are particularly relevant.

174. UNIDO's own industrial rehabilitation programme could serve as the basis on which an ESID-focused industrial productivity improvement programme could be built.

Notes

1/ United Nations Industrial Development Organization, Industry and Development: Global Report 1990/91 (UNIDO publication, Sales No. E.90.III.E.12).

2/ "Options to increase transfer of environmentally sound technologies to developing countries on favorable terms", United Nations Centre on Transnational Corporations, New York, 23 April 1991, Draft mimeo.

3/ George Heaton, Robert Repetto and Rodney Sobin, Transforming Technology (Washington, D.C., World Resources Institute, 1991).

4/ James A. Tobey, "The effects of domestic environmental policies on patterns of world trade: an empirical test", KYKLOS, vol. 43, 1990, pp./191-209.

5/ Heaton, Repetto and Sobin, op. cit., p. 30.

6/ United Nations Environment Programme, "Meeting of Experts Organized in Cooperation with the World Intellectual Property Organization on the Role of Intellectual Property in Technology Transfer as Provided for Under the Montreal Protocol", Geneva, draft report, 26-27 April 1990. Also, World Intellectual Property Organization, "Basic notions of industrial property and licensing" (WO/INF/51), Geneva, 20 April, 1990.

7/ International Environmental Bureau, "Technology cooperation for sustainable development", paper presented to the Second World Industry Conference on Environmental Management, 11 April 1991, Rotterdam.

8/ See, for example, Kurt Hoffman, "Technological advance and organizational innovation in the engineering industry", World Bank Industry Series Paper, No. 4, March 1989.

9/ "Guidelines for the Application of Economic Instruments in Environmental Policy", Environment Committee Meeting at Ministerial Level Organisation for Economic Co-operation and Development, Paris, January 1991.

10/ United States of America, Environmental Protection Agency, "Final Report to the Administrator of the U.S. Environmental Agency from the International Environmental Technology Transfer Advisory Board", Washington, D.C., 1990, p. 15.

11/ Organisation for Economic Co-operation and Development, The State of Environment (Paris, 1991), p. 274.

Annex I

THE ROLE OF THE UNITED NATIONS DEVELOPMENT PROGRAMME

1. The recommendations of the World Commission on Environment and Development provide the basis for the recent and future activities of the United Nations Development Programme (UNDP). More specifically, the Commission's concept of sustainable development is at the core of UNDP's collaboration with other United Nations specialized agencies, regional commissions and development banks, and independent sector organizations. UNDP's work with these groups has covered wide geographic and topical realms in promoting the integration of economic development and the environment.

2. In 1989-1990, UNDP concentrated on increasing the efficiency of policy, technical, and management support from the Bureau for Programme Policy and Evaluation and the regional bureaux. Each project considered by UNDP was tested for compatibility with the sustainable development concept. The overall operationalizing of sustainable activities in UNDP activities was accomplished by strengthening of the coordinating body, the Environmental Action Team. The Environmental Action Team promoted public awareness through the use of videos and various workshops, which led to reports and recommendations. During this time, UNDP also advocated the creation of the Sustainable Development Network (SDN), which would reinforce the connections among their 113 field offices. The soon to be finalized UNDP Environmental Management Guidelines offer advice on how to incorporate the principles of environmental management and sustainable development into daily activities. UNDP's Human Development Reports attempts to incorporate environmental considerations into their assessment of economic development. Again, workshops and seminars served as the vehicles of dissemination.

3. These UNDP activities facilitated international cooperation between developed and developing countries. The main issues of these activities were technology transfer in areas of urban transport, renewable energy sources, coastal management, combating desertification, sustainable management of tropical forests, maintaining soil productivity, waste management, chloro-fluorocarbons, biotechnology, atmospheric data collection, and natural resource accounting. The approach to handling these issues revolved around environmentally sound, equitable economic growth. Some specific actions include an assessment of the implications of China's participation in the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer, a pilot project for involving youth in environmental activities in the Dominican Republic, community-level and non-governmental organization networks in Africa and in Latin America, and collaboration with the World Meteorological Organization on climate change.

4. UNDP has supported numerous regional efforts to adapt specific recommendations of the Brundtland Report. These projects identify the needs of specific ecosystems, like the regional project for Amazonian cooperation. Regional projects exist in Africa, in the Arab States, and in Europe. Other specific actions included work with UNEP, UNESCO, and UNICEF on the World Conference on Education for All in March 1990 and a joint effort with the World Resources Institute to produce "World Resources 1990-91: A Guide to the Global Environment". UNDP is the lead financing agency for the Tropical Forestry Action Plans as well.

5. For 1991 and beyond, UNDP plans to continue with the projects and goals described above, while intensifying existing connections with other United Nations specialized agencies, especially UNEP. A stronger emphasis on community and grassroot projects will be followed through the arms of the 113 field offices. UNDP is actively involved in the Global Environment Facility, a clearinghouse and policy-guidance centre, along with the World Bank and UNEP. Further financial contributions by UNDP in research and development, technology transfer, mobilizing other resources and strengthening the technical and scientific human resources and policy frameworks at the country level will all be fully compatible with the complete union of development and the environment.

Annex II

DESCRIPTION OF ENVIRONMENTAL ACTIVITIES OF REGIONAL DEVELOPMENT BANKS

1. The Environment Division of the Asian Development Bank (AsDB) examines all AsDB projects for environmental soundness, in close cooperation with Member States and other international organizations involved in development. The Division is directly involved in the implementation of projects dealing with natural resource use and training of Bank staff. Since 1989, AsDB has been involved in institution strengthening programmes to enhance environmental protection in Bangladesh, Fiji, India, Indonesia, Malaysia, Nepal, Pakistan, Philippines, Western Samoa and Vanuatu.

2. The Environmental Unit within the Central Projects Department of the African Development Bank (AfDB) has a small staff responsible for coordinating all technical aspects of programmes related to the environment, developing environmental assessment guidelines and training other AfDB staff. Since 1989, AfDB policy has mandated a greater emphasis on environmental concerns in lending programmes in agriculture, transportation, industry, and health and education.

3. The Environmental Management Committee of the Inter-American Development Bank (IDB) embarked on an Environmental Work Plan in 1987 to propose environmental protection and mitigation measures for IDB programmes and can propose abandonment of projects it believes will result in serious environmental damage. IDB and the Organisation of American States (OAS) work jointly on feasibility studies of watershed management projects in the region and with the Pan-American Health Organization on projects related to health, water and sewage. In addition, the IDB provides training to public agencies in developing countries of the region in the areas of conservation and natural resource management.

Annex III

TRANSNATIONAL CORPORATIONS

1. The United Nations Centre on Transnational Corporations (UNCTC) recommends that decision makers in transnational corporations be required to prepare public environmental impact statements before instituting policy regarding transportation, energy consumption, waste disposal, or anything else that may affect the environment. Such a requirement would lead to the consideration of a broader range of alternatives than would be derived from the short-term profit motive alone. In the long term, including environmental concerns in strategic decision-making could lead to more efficient, cost-effective operations and could preclude the need for large investments later on to comply with ever-increasing environmental protection standards.

2. To the extent that additional investment is required, various incentives and regulations must be in place to establish a competitive environment in which "mortgaging the future" for the sake of short-term profit is an ineffective business practice.

3. Global environmental problems such as the greenhouse effect or acid rain deserve special attention from TNCs because, unlike local pollution problems such as unsustainable solid waste disposal, degradation of the atmosphere cannot be cleaned up by human intervention in most cases. Public and corporate policies do not yet take full account of the gravity of this risk.

4. In terms of public regulation and incentive policies to control emissions, there is as yet no policy - or even a mechanism for establishing policy - to regulate or impose liability on companies that contribute to the greenhouse effect. At present, public policy is limited to national borders. The best hope may therefore lie in the development by the private sector, primarily TNCs, of alternatives to chemicals such as CFCs. Regulation, whether it is global or not, will not be able to reduce destructive emissions and at the same time promote industrial development unless viable alternatives are available. Even now, UNCTC reports that many companies are saving money by using new processes that are more cost-effective and clean than those using CFCs. Major CFC producers that warned only a few years ago that the elimination of CFCs could mean the end of modern necessities such as refrigerators and personal computers, now consider the Montreal Protocol's goal of a phase-out of CFCs by the year 2000 to be achievable.

5. TNCs are under no general obligation to assess the environmental impact of their activities or to make such information public. Disclosure laws are now limited almost entirely to the need to demonstrate compliance with a few laws. Most countries have a number of laws related to local environmental concerns such as waste disposal, but no laws require TNCs to take account of the global environmental effects of their activities. Under these circumstances, companies that choose to disclose information only increase the likelihood of litigation and risk putting themselves at a disadvantage relative to companies that do not disclose. Systematic disclosure rules are therefore needed to encourage the exploration of clean alternatives to present practices.

6. UNCTC has developed "Criteria for Sustainable Development Management" to establish a foundation for stimulating management thinking on sustainable development. TNCs are asked to continuously evaluate their products, production processes and corporate objectives in light of environmental and public health, and then create a sustainable development policy that integrates their findings with other corporate objectives.

7. Industrial associations can assist in the creation of these policies by establishing environmental and energy use standards in the same way that they now set quality and production standards needed to maximize market performance. These associations have extensive experience, especially in the industrial world, in setting and enforcing responsible standards. There is no logical reason to assume that their role cannot be expanded. Standards for vehicles, lighting systems, cogeneration of energy and recycling are all potentially achievable.

8. For individual products, UNCTC recommends that TNCs prepare "generic environmental impact statements" to include estimated impacts of the products under normal use; an assessment of alternative production approaches; and a cost-benefit analysis that is quantified as much as possible, but which includes qualitative discussion of environmental externalities. For production facilities, an environmental impact statement should be specific to each plant and include comparative data on plants of similar size producing similar products.

9. Because TNCs do business in many countries, there is a need for a central agency to review these statements and file them in a database, which could be accessed by any country considering accepting TNC foreign investment. This information would also be invaluable in the development of local industries with limited technical resources.

10. Some attempts have been made to calculate the costs of global warming, including the EPA report, "Policy Options for Stabilizing Global Climate Change". However, a far more useful measure is an estimate of the costs of reducing greenhouse gas emissions compared to the cost of not doing so. However, the cost of inaction is practically incalculable. Even if the analysis is restricted solely to the costs of rising sea levels, the task is unmanageably large and it would be of little value because it would not include the still more enormous impact of changing seasonal cycles and increased exposure to ultraviolet radiation on the food supply and public health. However, it can be said that significant sea level elevation would hit TNCs particularly hard in monetary terms, given their investments in shipping, offshore drilling and coastal storage facilities.

Annex IV

INTERNATIONAL CHAMBER OF COMMERCE GUIDELINES

1. In November 1990, the International Chamber of Commerce adopted its Business Charter of Sustainable Development, which includes a set of Principles for Environmental Management to guide enterprises in their efforts to improve their environmental performance and to foster sustainable development by mobilizing managerial, technical and financial resources to resolve environmental problems. The Charter was one of seven projects initiated by business leaders from the industrial world at the Bergen Conference in May 1990 and was first publicly announced at the Second World Industry Conference on Environmental Management (WICEM II) in April 1991.

2. The Principles were prepared to demonstrate to companies that sound environmental management is a key determinant in sustainable economic growth and to strengthen the voice of business in the public policy debate over the environment by demonstrating to Governments and the public that business recognizes its environmental responsibilities and is formulating practical procedures to meet them.

3. The Principles recommend that firms need to remain informed about the increasing depth of scientific understanding regarding the environmental impacts of industrial activity and the technological developments that can help to use this research as a guide in modifying their activities. Where significant hazards cannot be eliminated, companies should have detailed emergency preparedness plans developed jointly with relevant authorities and local communities. When significant technical or managerial solutions are developed, the Principles encourage companies to disseminate them as widely as possible and contribute their new knowledge to the development of public policies and educational programmes.

4. Environmental impact assessments made before a new activity is initiated will encourage the development of new products that have minimal destructive effects, particularly if producers increase their efforts to advise customers on the use, transportation, storage and disposal of their products.

5. In designing facilities, care should be taken to ensure the efficient use of energy and material, recycling wherever possible and disposing of remaining waste safely. For operating facilities, the Principles encourage companies to continuously measure and improve their environmental performance through environmental audits.

6. Companies are also encouraged to promote these Principles among their suppliers and contractors and to use their leverage to ensure compliance.

Model steel mills in Argentina and Thailand

Model steel works in Argentina and Thailand have been identified and given assistance in optimizing their environmental performance in order to act as training and demonstration centres.

UNIDO is implementing the programme, which is funded by the Japanese Government.

Steel production uses a lot of energy and generally pollutes heavily. Properly managed, the environmental problems can be significantly reduced. The model steel works programme aims to train and motivate key personnel at all levels. Environmental focal-points in the companies have been identified and trained, and will act as trainers themselves in the future. The plants will function as centers for training and demonstration, and a set of handbooks has been developed. Practical advice is provided on how to deal with some of the usual environmental problem spots - pickling lines and settling ponds, fine dust from electric arc furnaces, steelmaking slag and sinter plants, storage, slaking and reuse of lime, waste water from hot rolling mills and heat recovery from the MIDREX plant and reheating furnaces. The programme has also provided instruments and methodology for environmental monitoring.

Based on experience gathered, three new regional projects are planned for Latin America, South-east Asia and North Africa.

REPORTS OF TECHNICAL SYMPOSIUMS

REPORTS OF TECHNICAL SYMPOSIUMS

Contents

I. ALUMINA INDUSTRY

1. The Symposium was held on 15 October 1991. Members of the Panel were P. Siklosi (Consultant), F. Balkau (Moderator) UNEP/IEO, T. Grof (Rapporteur) UNIDO, F. Panzeri (Industry representative) Italy, and R. Luken, UNIDO Secretariat. Ms. Taschner from the European Environmental Bureau made an intervention from the floor on behalf of NGOs.

2. Mr. Siklosi briefly summarized the case study and highlighted the main environmental issues now confronting the alumina industry. These include pollution, waste disposal, energy, occupational health and safety.

A. Introduction

3. Bauxite mining causes unavoidable ecological disturbance, and in some circumstances the issue of preservation of biodiversity is important.

4. Industry has numerous options for addressing environmental issues. Many of these are based on reducing in-plant losses and are achieved by a general improvement in operating efficiency, thus achieving both economic and environmental goals simultaneously. Some measures, however, especially those concerning mine rehabilitation and waste disposal, will entail an additional non-recoverable cost. Total costing procedures and harmonization of environmental requirements are needed to encourage the uniform application of all environmental measures.

5. Traditional environmental issues of pollution and waste disposal are generally well appreciated by the industry. Consciousness of energy consumption as a major issue confronting the sector is also rising, and many initiatives are being undertaken to reduce energy consumption.

6. A number of specific technical questions were raised during discussion about such issues as caustic soda recovery, construction of red mud disposal basins, and use of red mud as a soil conditioner or even as artificial soil.

B. Recommendations

7. Industry experts summarized the most promising ways of reducing the negative environmental impact of the alumina industry at the plant level as follows:

(a) Reduction of the amount of natural resources (primarily energy) consumed per unit amount of alumina manufactured;

(b) Reduction of the residual discharges (effluents, dust, stack gases) per unit amount of alumina manufactured;

(c) Environmentally sustainable discharge and storage of digestion residue (dry stacking of red mud), recultivation of the filled-up storage areas.

8. The above can be realized by:

(a) Better operational and maintenance practices (e.g. preventing leakages, proper heat insulation, maintaining the prescribed parameters of the process, etc.);

(b) Economically reasonable measures for efficient resource utilization, pollution control and waste disposal (e.g. increasing the number and size of heat exchangers, washing stages, etc.);

(c) Measures necessary to meet environmental requirements conforming with the generic ESID norms (e.g. installing dust collectors, scrubbers, dust filters, red mud filters or deep thickeners, recultivating mined-out areas and filled-up mud disposal areas, etc.) even if costly.

9. In general, it can be said that whereas modifications to existing old plants are relatively costly (they may reach even 30 to 50 per cent of the original investment costs), those incorporated in the engineering designs of a new plant (or of a significant expansion of an existing one) do not increase the capital costs by more than 5 to 10 per cent. At the same time the latter usually enable such savings to be made (both in related investment and operating costs) that they can make the application of environmentally sustainable solutions profitable.

10. As a general rule, it was agreed that sound methods of operation and of waste disposal do exist, but that they are not always applied due to lack of information, expertise or capital.

C. Discussion

11. During discussion, delegates raised the importance of broader issues which affect the industry as a whole. These broader issues include:

(a) Promotion of recycling as a means of reducing energy and resource demand, both of which have unavoidable environmental impact;

(b) Application of total life-cycle considerations within the industry so as to minimize overall environmental impact, and to avoid shifting environmental impact between different sectors;

(c) Possibility of increased residue and waste utilization outside the plant so as to reduce the need for disposal. There are already many useful re-use options; nevertheless, further R and D and demonstration projects should be encouraged so as to expand further these options. The practical application of re-use will always be strongly dependent on local and regional

circumstances, and also requires study in each case. Despite increased waste re-use in the immediate future, alumina plants will still need to rely heavily on well-engineered waste disposal methods;

(d) A closer harmonization of environmental standards and procedures around the world is desirable so as to reduce trade distortion. Project costing methodologies should include an estimate of environmental damage so as to achieve a total cost concept of alumina production;

(e) Corporate responsibility for environmental performance should be strengthened. Companies need to take a long-term view of environmental performance as well as paying attention to immediate impacts;

(f) Increased consideration needs to be given to interlinkages within the sector - vertical linkages within the aluminium industry as a whole so as to apply total-environment and life-cycle concepts, and horizontal linkages so as to maximize the contribution to environmental performance from suppliers and from waste re-use activities.

12. A general view from the discussion was that increased emphasis on information collection and dissemination concerning methods of reducing environmental impact would help many enterprises, especially those which are not linked with large vertically integrated companies.

II. LEATHER INDUSTRY

1. The Symposium on the leather industry was held on 15 October 1991. Members of the Panel were K. Higham (Consultant), Ms. G. Stoikov, International Labour Office (Moderator), J. Buljan, UNIDO (Rapporteur), R. L. Sykes, United Kingdom (Industry representative), A. Jernelov, Sweden (NGO) and R. Williams, UNIDO Secretariat.

2. Mr. Higham briefly summarized the case study and highlighted the main environmental issues.

A. Discussion

3. Technology: It was agreed that R and D had made great progress and that well-proven cleaner production methods are available. However, there still remains a number of barriers such as dissemination of information about cleaner technologies which are not always easily available to the tanning industry.

4. There is also the problem of transferring technology from the R and D laboratory into practical everyday use, especially in small- and medium-scale tanneries. Low-waste technologies very often require better skilled personnel at all levels and closer technical supervision than conventional processing. This is, in many instances, a crucial constraint. In a number of developing countries there is a lack of know-how in the design, installation, and efficient operation of effluent treatment plants.

5. Owing to the nature of leather production, even in the most sophisticated tannery, technology remains to a certain extent a mixture of craft and science. Nevertheless, unnecessary conservatism remains in some instances a significant barrier.

6. Financial aspects: The issue of cost and financing was discussed and there was a general consensus that cost constituted an obstacle to the implementation of clean and safe production of leather. Within this context the cost of specialty chemicals needed to replace conventional substances and the cost of process and water consumption control equipment were specifically mentioned.

7. In general, the cost of ecologically sound equipment is even more prohibitive in developing countries than in developed countries because of high capital costs and very often high import duties. In addition, there is the cost of hiring and training the personnel needed for the operation of new equipment and processes.

8. Sharing of responsibilities: There was a lively debate on how to share the responsibilities for preventing pollution and cleaning up. A special issue raised was the role of Governments, industries, R and D institutions, monitoring/enforcement organizations, and consumers.

B. Recommendations

9. Delegates and industry experts summarized the most promising ways of reducing the negative environmental impact of the leather industry. It was agreed that the overriding principle is that prevention is better than cure, and that pollution prevention and waste management systems should be integrated at all levels. The following recommendations were made:

(a) Government and industry should cooperate in order to:

(i) Develop fair and implementable environmental legislation;

(ii) Promote cleaner and cost-efficient technologies at all stages of leather production and waste management (this could possibly include the relocation of tanneries, where appropriate);

(iii) Devise innovative fiscal and other incentives to encourage tanneries to use cleaner production and waste management methods;

(iv) Develop and/or strengthen R and D facilities to satisfy the specific needs of the local industry, and where possible, also install pilot and demonstration plants and laboratories;

(v) Launch environmental awareness and public education campaigns and provide the necessary training for executives, supervisors and operators;

(vi) Increase the use of environmental audits;

(vii) Provide the necessary infrastructural support (utilities, land, sewage, landfills for disposal of solid wastes, etc.).

(b) At the plant level the following measures requiring limited investment could lead to significant reduction of pollution loads:

(i) Strict process control;

(ii) Good housekeeping;

(iii) Recovery and/or recycling of chemicals;

(iv) Proper maintenance and repair of equipment;

(v) Introduction of sound management concepts.

Further measures to reduce the pollution load could include the utilization of waste of commercial value for the production of glue, gelatine, fertilizers, animal feeds, etc. However such operations are very often profitable only in large tanneries. The need for technical cooperation in setting up joint effluent treatment plants for groups of tanneries and isolated individual tanneries was also expressed. To ensure a healthy working environment for the benefit of all staff is the special responsibility of tannery management.

(c) International and relevant national agencies should:

(i) Facilitate the advancement of networking of global capabilities and programmes in the R and D institutions and provide access to relevant information at the national and international level;

(ii) Ensure the transfer of cleaner technologies and low-cost waste treatment systems by means of databases, audio-visual training packages, workshops, seminars, symposia, etc.;

(iii) Make available attractive financial terms (soft loans) and support from international institutions. This would overcome the disincentive to change caused by high initial investment. Such support should also be in the form of demonstration projects illustrating tannery partial and full automation, and include development of human resources;

(iv) Organize a special conference on low waste technologies for the leather industry in developing countries.

III. PHOSPHATE FERTILIZERS

1. The Symposium on phosphate fertilizers was held on 17 October 1991. Members of the Panel were J. Schultz (Consultant), R. N. Roy, Food and Agriculture Organization (Moderator), I. Volodin, UNIDO (Rapporteur), O. Lie, Norsk Hydro (Industry Representative), M. Handley, International Fertilizer Association Technical Committee (Industry Representative), J. H. Oxley and S. Luken, UNIDO Secretariat.

2. Mr. Schultz briefly summarized the case study and highlighted the main environmental issues.

A. Introduction

3. The importance of mineral fertilizers for agriculture cannot be underestimated. Fertilizer is one of the major inputs that enables adequate food production and maintenance of soil fertility on a sustainable basis.

4. There is no doubt that, without fertilizers, sustainable agriculture required to feed the world's growing population cannot occur and the most critical issue is not to stop fertilizer production, but to try to find ways and means, at the level of industry, to maintain ecologically friendly and sustainable production. In other words, how to achieve ESID in this subsector.

5. It is crucially important to identify the criteria for ecological sustainability in industry and agriculture. This has turned out to be a very challenging task. Every attempt brings out a number of issues that need to be addressed. In many respects, the scientific, financial, and political community has not been fully challenged to address the question of quantifying the complex relationships of these issues.

6. These issues are:

(a) The transfer and execution of ESID technology;

(b) The coupling of agronomic needs with more environmentally benign phosphate production technology;

(c) The seeking of financial resources to implement ESID;

(d) The restrictive fertilizer product legislation that inhibits implementation of ESID;

(e) The heavy metal content associated with the phosphate sector, especially cadmium;

(f) The management of process wastes and by-products associated with the phosphoric acid-based products;

(g) The improved agronomic efficiency to help mitigate the impact of the increased cost of ESID.

7. The Panel discussion identified the major barriers and proposed some initiatives for achieving ESID in the fertilizer industry.

8. A summary of these barriers, with no reference to priority or importance, follows:

(a) Lack of definition of acceptable minimum global environmental standards;

(b) Cost required to implement available and emerging ESID technology;

(c) Major investments required to change product mix (product types and solubility);

(d) Limited availability of foreign exchange;

(e) Marginal competitive status within the phosphate fertilizer industry;

(f) Lack of significant farm level cost differences between conventional and more environmentally benign products;

(g) Restrictive fertilizer product legislation;

(h) Difficulty in changing farmers' practices.

B. Recommendations

9. The following recommendations emerged from the work of the symposium.

(a) Encourage the international community to convene an international working panel of experts from industry, national and international regulatory bodies, and the scientific community to draft

proposed minimum environmental compliance standards for the phosphate fertilizer production sector appropriate to country location, taking into consideration scientific data, costs, available capital, and national development priorities. Similar initiatives should be taken in regard to phosphate fertilizer use;

(b) Initiate a critical scientific look at issues related to cadmium, fluorine and other potentially hazardous substances occurring in the production and use cycle of phosphate fertilizers taking into consideration other contributive sources;

(c) Communicate industry and process-specific engineering and operational technology to producers in developing countries that is designed to achieve ESID, through optimization and retrofitting of existing facilities at low cost as opposed to total replacement of facilities at high capital cost;

(d) Develop an implementation timetable on a national basis for attaining ESID consistent with the availability of capital and the operation of the industry in a competitive, yet sufficiently profitable manner;

(e) Provide assistance in securing the necessary capital for cost-effective implementation of identified ESID initiatives;

(f) Encourage the industrial community to intensify its commitment to R and D designed to expedite technology development and technology transfer leading to ESID;

(g) Improve phosphate fertilizer use efficiency at the farm level to help offset the increased cost of phosphate fertilizers that is likely to be attributed to ESID;

(h) Promote national fertilizer legislation relative to product types and characteristics that is consistent with achieving the appropriate agronomic performance, while not unduly restricting raw material and manufacturing choices that may facilitate more rapid adoption of ESID;

(i) Encourage national policy initiatives relative to fertilizer pricing and distribution that promotes the local production of more environmentally benign fertilizer products based on domestic resources, provided these alternative products are competitive in real terms with imported products that are produced in world-scale production units.

C. Discussion

10. As a result of the presentation by the Panelists and the summary drawn up by the Moderator, a consensus was evident with regard to the technical content of the case study. The delegates, however, focused their attention on a number of specific issues with particular reference to the following:

(a) There is no substitute for phosphate, any reduction of its use would result in the reduced production of food, fibre and edible oils;

(b) Concern was expressed regarding the lack of representation of bodies concerned with public opinion on environmental issues;

(c) Cadmium and other heavy metals were identified as a major concern affecting the production, trade and use of phosphate raw materials and products. The concern is related to their impact on human and animal health through the food chain;

(d) Fluorine contained in phosphate fertilizer raw materials and products was identified as a potential contaminant of surface and groundwater;

(e) Concern was voiced that less beneficiated (pure) phosphate products considered more environmentally benign may actually contribute to increased levels of undesirable metals in the finished phosphate products;

(f) Concern was raised that reclamation at mined-out lands may be excessively costly in certain mining scenarios;

(g) An issue was raised relative to the feasibility of incorporating phosphogypsum disposal with the reclamation at mined-out areas;

(h) A number of delegates indicated that relatively extensive research is already under way for finding cost-effective methods for removing cadmium, fluorine and other potentially hazardous elements from phosphate materials;

(i) Concern was expressed about the need for immediate assistance in technology transfer to developing countries to achieve ESID. To this effect, it was suggested that a special fund should be created;

(j) Concern was expressed with regard to the disposal of fluosilicic acid recovered from phosphate processing in those locations where markets for this by-product material do not exist;

(k) It was mentioned that bentonite when added to sandy soils improves moisture-holding capacity and fertilizer use efficiency. Immobilization of cadmium was also suggested due to the betonite;

(l) Concern was voiced with regard to the problems that would be caused by unilateral environmental legislative initiatives;

(m) There was significant support for the concept of using less soluble phosphate fertilizers provided they are effective;

(n) Concern was expressed about the very high level of SOx pollution from a few plants in developing countries representing a very high proportion of industry's worldwide SOx pollution in addition to being a serious regional source of pollution.

IV. PLASTICS AND PLASTICS WASTE RECYCLING

A. Introduction

1. The Symposium was to be held on 17 October 1991, but by request of the Italian delegation a preliminary gathering was held on 15 October 1991. Members of the Panel were Prof. A. Buekens (Consultant), A. Sieber, Economic Commission for Europe (Moderator), Ms. A. Tcheknavorian-Asenbauer (Director, IO/T, UNIDO), J. H. Oxley (Rapporteur) UNIDO, and D. Rehling (European Environmental Bureau) and R. Williams, UNIDO Secretariat.

2. The case study was summarized by Prof. Buekens who pointed out various technical and economic

challenges to be met. Plastics belong to various mutually incompatible generic groups. Each variety is manufactured in numerous grades with different molecular weight and structure. Moreover, plastics are transformed only after admixture of a host of different additives. A first challenge is hence identification of a particular grade that can be recycled as a more or less homogeneous function.

3. During processing and later use the resin undergoes ageing, as a consequence of thermal degradation, oxidation, cross-linking, loss of additives, etc. Plastics also take up impurities, such as traces of materials e.g. moisture and printing inks.

4. A survey was given of various methods of materials recycling, including those after chemical reprocessing (pyrolysis, hydrolysis) and energetic usage.

5. Technically speaking, many problems have been solved. The logistics of collection and transportation, the required grading, shredding, cleaning, regranulation and marketing greatly add to the cost of secondary plastics, whereas their quality goes down.

B. Recommendations

6. It is suggested that Governments:

(a) Take the initiative to foster the development by industry of appropriate and internationally standardized means of identifying the type of plastic used in a product (e.g. by adding trace amounts of fluorescent additives);

(b) Encourage the production and use of utilitarian products (e.g. park benches, acoustic walls, fences) which can be made from recycled plastics out of mixed consumer waste;

(c) Should ban uncontrolled, unhygienic forms of scavenging in developing countries and encourage systematic collection at the source (e.g. households).

7. It is suggested that industry:

(a) Should, as far as possible, avoid using more than one type of plastic for a given article;

(b) Should develop products which can be made from recycled plastics composed of two or more commingled types;

(c) Should develop the production of plastic goods which are easily recycled;

(d) Should assume responsibility for the products it takes to the market with inclusion of all environmental and safety aspects.

8. It is suggested that international organizations, such as UNIDO:

(a) Should be encouraged to continue providing technical assistance aimed at improving the efficiency of plastics transformation industries in developing countries, so as to improve the performance and life of plastic articles, thus avoiding waste;

(b) Should promote the creation of small industries in developing countries to make maximum use of secondary raw materials, in particular plastics contained in the waste stream.

C. Discussion

9. In the case study and the following discussion considerable attention was given to the huge technical and economic barriers to be overcome:

(a) The great variety of plastic resins, grades and additives in use defies precise identification and sorting;

(b) The decrease in mechanical properties as a consequence of ageing, thermal degradation during reprocessing, photochemical degradation, oxidation, cross-linking, loss or consumption of stabilizing additives and antioxidants, etc;

(c) The uptake of contaminants, such as traces of packed materials, moisture, inks, solvents, etc;

(d) The lightness and widespread use of post-consumer waste makes it a challenge to retrieve sizeable amounts of waste plastics at a reasonable cost;

(e) The variable and ill-defined specifications of reclaimed plastics.

10. The cost of collection, identification, sorting and grading, shredding, cleaning, regranulation, processing and marketing was noted to be higher than for virgin plastics, taking into account the decreased productivity obtainable with reclaimed plastics as a consequence of their variable melt and flow behaviour. During the discussion the necessity of marking plastics was stressed. The need for industry to use technical and business ingenuity in developing the plastics production transformation and recycling industries, as well as in the packaging industry, so as to minimize unrecyclable waste was also mentioned.

11. Attention was paid to:

(a) Governmental measures to encourage or even to enforce recycling quotas;

(b) The economic incentives to promote recycling activities despite large fluctuations in the cost of virgin materials;

(c) The viewpoints of collecting and recycling firms;

(d) The growing sense of responsibility in some branches of industry (car manufacturers) in order to favour recycling of spare parts or plastic materials.

V. PULP AND PAPER

A. Introduction

1. The Symposium on pulp and paper was held on 14 October 1991. Members of the Panel were F. Fellegi (Consultant), Nay Htun, UNCED (Moderator), R. V. Assumpcao, UNIDO (Rapporteur), Prof. N. Hartler, Royal Institute of Technology, Sweden (Industry representative), Marga et Rainey, Greenpeace International, and R. Williams, UNIDO Secretariat.

2. Mr. Fellegi briefly summarized the case study and emphasized the main differences between developed and developing countries with regard to fibrous raw materials used for pulping, economic conditions, and the level of technology. He also reviewed the impact of these differences on the

environmental situation and barriers on the road to an ecologically sustainable development in this industry. The UNIDO representative outlined that Organization's activities aimed at improving the environmental situation and proposals for future activities.

3. Industry experts reached the following conclusions based on the case study:

(a) Sustainability must be judged in a broad sense considering the product "from cradle-to-grave";

(b) Wood is a dominating raw material and in the large producing countries it is managed on a sustained basis;

(c) Large-scale modern pulp and paper manufacturing has been greatly improved, resulting in a potential for producing pulp and paper with minimal environmental disturbance. In developed countries, very large investments have already been made in the industry and more are planned. In mills that are small and old and use non-wood fibres, there is significant scope for improving the environmental situation;

(d) The subject of whether to totally exclude molecular chlorine and possibly chlorine dioxide in pulp bleaching is still open;

(e) Emission to air of acidifying gases can be greatly reduced by modern technology;

(f) In the case of chemical pulping it is possible to produce all energy required internally and also to produce some surplus with low emissions of acidifying gases;

(g) The product "paper" is environmentally friendly. It is produced from renewable raw materials and is biologically degradable. By applying new technologies it is possible to produce bleached products with dioxin content at the same level as for unbleached pulp;

(h) There is today a considerable move to expand use of recycled paper in traditional fields. All fibres cannot be recycled for reasons of fibre quality as well as hygiene. The non-recycled part of waste paper should be used for energy production, with no disturbance of the global carbon dioxide balance.

B. Recommendations

4. To overcome barriers, Governments are requested:

(a) To introduce environmental standards, if not yet established;

(b) To enforce such standards and to support the introduction of clean technology by tax incentives;

(c) To reduce or to abolish existing import duty on waste paper and equipment for clean technologies;

(d) To introduce charges for pollution and use the collected funds for subsidizing clean production technologies in the pulp and paper industry.

5. Industry is advised:

(a) To improve management, housekeeping and engineering, by reducing the environmental impact of production, especially by accidental discharges;

(b) To reduce water and energy consumption in pulp and paper making;

(c) To introduce internal environmental monitoring and auditing;

(d) To consider reduction of chlorine in the bleaching process;

(e) To cooperate with national and international organizations in developing indigenous clean technologies or by adapting foreign know-how to local conditions;

(f) To consider, in developing countries, the possibility of grouping small pulp mills to recover the chemicals from black liquor;

(g) To improve, at all levels, management and technical skills in the mills in cooperation with the Government and international organizations.

6. International organizations are requested:

(a) To intensify the flow of information on clean technologies between countries;

(b) To promote research and development of technologies for pulping, small-scale chemical recovery and bleaching with regard to non-wood materials such as:

(i) Sodium-oxygen, potassium hydroxide, soda antraquinone, organosolv pulping;

(ii) Chlorine-free bleaching using oxygen, oxone, hydrogen peroxide as well as biobleaching;

(iii) Alternative processes for small-scale chemical recovery and utilization of black liquor;

(c) To disseminate know-how gained under UNDP/UNIDO projects regarding treatment of black liquor and effluents;

(d) To provide assistance to institutions in developing countries to develop indigenous technologies for clean production and further the cooperation between industry and such institutions world wide.

7. The representative of Greenpeace International presented a statement with the following recommendations:

(a) In order to achieve ESID, the discharges of organochlorine compounds should be phased out through the use of clean production methods, i.e. phase out all chlorine-based bleaching;

(b) To increase recycling of waste paper by at least 5 per cent per year to achieve a global recycling rate of 50 per cent by the year 1995;

(c) To prohibit all forestry practices that cause biodiversity reduction. Pulp producers should install a biodiversity monitoring programme in all forests where wood is extracted.

C. Discussion

8. It was stressed that the most important barrier to introducing ESID in developing countries is finance. There are still technical and economic barriers to achieving ESID when using non-wood raw materials, especially in small mills. Another barrier is lack of technical skills and education.

9. Other considerations were:

(a) Good housekeeping and engineering practices, e.g. avoiding accidental discharges of polluting substances, good management of wastes, optimizing raw material utilization and life-cycle approach (cradle-grave) are significant steps in achieving clean production;

(b) Emerging trends in pulping, washing of pulp, chemical recovery and bleaching, e.g. use of potassium hydroxide instead of sodium hydroxide, simplified chemical recovery, etc;

(c) Waste paper should be recycled and new environment friendly printing inks should be used;

(d) The problem of completely chlorine-free bleaching was discussed and mention was made that production of high brightness pulp without chlorine compounds is at the present time not realistic. However, lower whiteness paper can be produced by using pulps bleached with a low chlorine charge or without chlorine, if acceptable to consumers.

10. It was suggested to complement the case study by adding current statistics on pulp production and processes giving details of developed and developing countries.

Pulp and Paper

Case study No. 1

Executive Summary

INTRODUCTION

The Pulp and Paper Industry, Resources and Processes

The total world production of paper and board in 1989 was 233 million tonnes and of pulp 164 million tonnes. About 85 per cent of paper and board and 87 per cent of pulp was manufactured in developed countries. The expected increase in the consumption of paper and board will be 3.4 to 3.6 per cent in developed countries and 5.8 to 5.9 per cent in developing countries. The expected annual growth in the pulp production will be 2.9 to 3.1 per cent in developed countries and 4.4 to 4.5 per cent in developing countries.

The basic raw materials used in pulp manufacture are renewable lignocellulosic fibrous materials. In developed countries wood is mainly used for pulping. In many developing countries, wood is in short supply and more than 45 per cent of the pulp is manufactured from other fibrous materials, mainly agricultural residues such as straw, bagasse and bamboo. About 55 per cent of the other fibre pulp is manufactured from straw.

Chemical and mechanical processes are used in pulp production but pulp is mainly produced by chemical processes. Among these processes, kraft for wood and soda for non-wood pulping predominate. Both operate in alkaline conditions.

The basic steps for pulp production are: fibrous raw material preparation, pulping, screening, washing, bleaching and recovery of chemicals.

The paper industry uses both virgin fibres produced by pulping of lignocellulosic fibrous raw materials and also a considerable amount of recycled fibres (waste paper) besides non-fibrous materials (chemicals, minerals e.g. china clay).

The industry has an impact on air, water and land. The extent of this impact can, in part, be controlled by appropriate technology. There are still technical and economical difficulties in pollution abatement, particularly in collecting and burning black liquor and recovery of chemicals in small pulp mills.

In most developed countries forest management is based on the method of sustained yield. It ensures that annual growth is at least equal to cut volumes. In some countries, e.g. Germany, it is general practice to make almost exclusive use of thinning material and industrial wood residues for pulp production. Use of forest resources is harmonized with environmental protection.

Cleaner production options

Preparation of fibrous raw materials

Prior to pulping wood has to be debarked and, since bark has a value as fuel, many mills prefer to debark in the mill and utilize the bark to generate process steam. Logs are debarked either in wet debarking drums or by dry debarking methods. In dry debarking the Biochemical Oxygen Demand (BOD) discharges are lower than in wet debarking.

Bagasse has to be depithed before pulping and this operation is normally made in two steps. The first step, wet depithing, is made in the sugar mill and material removal is burned in the sugar mill boiler. The second step is made in suspension in the pulp mill before pulping. Solid material, removed from bagasse, can be mechanically separated from the liquid phase which is recirculated. This mechanical separation and recirculation reduces to a large extent discharges of suspended solids.

The predominant treatment during bagasse storage, to avoid excessive degradation, involves spray and circulation of biological liquors or water. From the environmental point of view treatment with biological liquors is better than with water as discharges are reduced, although operating costs are higher.

With other non-wood raw materials such as straws and kenaf the tendency is to improve harvesting and collection to reduce contaminants carried to the pulp mill.

Pulping

Wood is usually digested by the kraft process. Some organic substances are volatile and are contained in the digester and evaporator condensates contributing to the BOD load by 12 to 20 kg BOD per tonne of pulp. During the digestion, metoxyl groups are split off producing methanol and also reacting with sodium sulphide forming odorous compounds. The amount of total reduced sulphur (TRS) is about 3.5 to 5 kg per tonne of pulp, the higher value related to hardwoods. Bamboo is usually pulped by the sulphate process.

In order to reduce the formation of malodorous compounds during kraft pulping the amount of sodium sulphide (sulphidity) in the white liquor should be reduced. One option is the partial or complete substitution of sodium sulphide by antraquinone and its derivatives. The quality of the pulp will be lower than kraft and the reduction in quality will depend on the extension of the substitution. This option is being commercially applied in some mills in developed countries.

Pulping with organic solvents, ethanol, ethanol-caustic soda, methanol, and sulphide-antraquinone-methanol (ASAM), acetic acid etc., is being studied at laboratory, pilot plant and demonstration level. Other recent developments in kraft pulping include: extended delignification in continuous digestors to reduce the residual lignin in the pulp (kappa number) without reduction in the pulp quality and in-digestor displacement, in batch digestor, to reduce steam consumption and improve pulp quality.

Agricultural residues are usually digested by the soda process (without sodium sulphide). The discharge of TRS (odorous compounds) is negligible as only traces of sulphur are present from water and raw materials.

An alkali-oxygen process for pulping of straw is emerging. This uses sodium carbonate and caustic soda as the cooking agent together with oxygen. Caustic soda should be used only as a make-up chemical, resulting in recovery without causticizing. A similar process is being developed for other non-wood fibrous raw materials.

Washing and screening

An important operation is washing of the pulp and extraction of the black liquor containing the dissolved organic substances. Vacuum and pressure drum washers are commonly used, mostly in three stages. Black liquor washing efficiency is from 96 to 97 per cent. The efficiency of modern belt washers is as high as 99 per cent. With this development the technological limits are most probably reached and, in the future, efforts will be directed to increase capacity and energy saving for drives and vacuum systems.

In old mills pulp is screened after washing, leaving shives and knots only partially washed and discharging BOD load in the screening system. By means of closed, hot screening the effluent can be reduced with corresponding decrease of BOD load. A closed system with good spill collection also decreases discharges of suspended solids.

Washing of agricultural residue pulp is less effective and more capital intensive as drainage properties of these are poor and the loading capacity of drum filters low. Bagasse pulp is easier to wash than straw pulps. Application of belt washer to straw pulp washing in China gave better results than press or vacuum washer applications.

Recovery of chemicals

The recovery of the chemicals from soda or kraft black liquor is a vital part of pulp production because it regenerates chemicals to form fresh digestion liquor, supplies heat for the pulp mill, and reduces discharges of wastes to the environment.

In the recovery process black liquor is concentrated in multiple effect evaporators frequently followed by a direct contact evaporator using flue gases, and is incinerated in a recovery furnace. In the kraft process, sodium sulphate is added to make up for losses. The smelt generated in the furnace is dissolved in water and caustic soda and regenerated by caustizing with lime.

Recovery of chemicals from agricultural black liquors is more difficult and less efficient. Black liquors from agricultural residues are less concentrated, caused by difficulties in washing.

The high silica content of non-wood pulps, mainly straw pulps, causes many problems in the recovery cycle including scale formation in evaporator tubes, deposits in the walls of the recovery boilers, slow setting rate of recausticizing white liquor, and lime sludge unsuitable for reburning. Desilication is required for successful recovery of high silica containing black liquor. UNIDO has developed a successful process at the Central Pulp and Paper Research Institute in India, and the Hindustan Newsprint Ltd. mill, Kerala, India has installed a demonstration plant.

A high-efficiency recovery system with a sophisticated furance is very expensive and hardly accessible to small mills. A Brazilian mill using bagasse has successfully installed a simplified version called a Broby smelter. China has developed recovery furnaces suitable for non-wood black liquor and installed them in several mills producing 10,000 to 15,000 t/a of pulp. Recently China developed a furnace for a 25 t/d straw pulp mill. The furnace reportedly is operated without auxiliary fuel.

Condensates from evaporation from a digester contribute substantially to the BOD load. Condensates in the kraft process contain methanol and also malodorous substances (TRS). It is necessary to clean the condensates by stripping and to incinerate them in a suitable furnace e.g. in the bark furnace or lime kiln.

For small pulp mills some possibilities for cleaner pulp production are being studied including simplified recovery furnace, recovery using amphoteric oxides, ferric oxide binding alkali during burning, separation of the lignin and inorganic compounds by ultrafiltration, and anaerobic digestion of black liquor.

Bleaching

Traditional methods to bleach chemical pulps involve treatment with chlorine and chlorine derivatives (chlorine, chlorine dioxide and hypochlorites). The residual lignin is dissolved as chlorinated compounds some of which are toxic.

The tendency is to substantially reduce discharges from the bleaching area. In developed countries, in addition to traditional limits in BOD, Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS) discharges, limitations are being introduced for toxicity and organochlorine compounds (AOX) discharges.

The cleaner production options in bleaching, mainly applied to wood pulp, are basically the following:

- reduce the black liquor content in washed pulp by using more efficient washers;
- reduce the residual lignin content of the brown pulp. This can be done through: extended delignification in continuous cooking operation; additive cooking by adding antraquinone or polysulphide; in-digestor displacement for batch digestor; and pre-bleaching with oxygen (oxygen delignification) reinforced or not with hydrogen peroxide;
- reduce the chlorine charge by reduction of the chlorine multiple;
- substitution of elementary chlorine by chlorine dioxide in first bleaching stage to reduce formation of the dioxins and furans;
- utilization of oxygen or oxygen/hydrogen peroxide reinforced alkali extraction;
- chlorine-free bleaching by using oxygen hydrogen peroxide and ozone. The final brightness of the pulp will be lower, around 80° to 85° ISO, depending on the sequence used and pulp characteristics;
- activated sludge treatment of bleaching effluents as well as aeration with oxygen;

All these options are being applied commercially in large mills in countries where discharge limits are strict. For small mills using non-wood raw materials, however, modification of these technologies is necessary. Possibilities being explored are the use of hydrostatic pressure oxygen reactors for bleaching straw pulp, and the utilization of enzimes to make lignin more accessible in bleaching and to reduce chlorine charge.

Another way to reduce discharges in bleaching is to reduce the final brightness of the pulp, but this will depend on the acceptance by the consumers of a paper with lower whitness.

Mechanical pulping

The BOD and COD load generated in mechanical pulping is just a fraction of the load generated in chemical pulping, but equal to or higher than the total discharge from chemical pulping with recovery. Biological treatment especially for Thermo Mechanical Pulping (TMP) and Chemical Thermo Mechanical Pulping (CTMP) is required to reduce pollution. Resins in wastewater from mechanical pulping are toxic and may disturb anaerobic biological treatment.

Mechanical pulps are produced mainly from wood, but in countries with shortages of wood pulp it is produced from bagasse by mechanical treatment in disc refiners. This pulp is mainly used for the production of newsprint paper.

The pulp yields in mechanical processes are from 80 to 95 per cent depending on the amount of chemicals used for impregnation. This is one advantage from the point of view of wood consumption. However energy consumption in these processes is higher than in chemical processes and, if energy is generated by thermoelectric units, the final balance will have to evaluated.

Waste paper

Waste paper is an important raw material in paper production and especially paperboard manufacture. Waste paper is one of the most significant parts of post-consumer refuse yet less waste paper is utilized than discarded as garbage. Less than 40 per cent of waste paper is actually collected. The highest waste paper utilization rates in fibre furnish is recorded in the Netherlands, the United Kingdom and Denmark, where it reached around 60 per cent in 1990. In Asia many countries are above 50 per cent and in the Republic of Korea about 70 per cent. Utilization of waste paper for papermaking is ecologically desirable, as it reduces refuse and extends the life-cycle of carbons in waste paper fibres. In countries with shortage of other fibrous raw materials waste paper utilization is preventing over-cutting of forests. Replacement of virgin pulp by waste paper also decreases energy demand, as energy consumption in waste paper processing requires approximately 1.3 MWh/t compared to 4.2 MWht/ for bleached kraft pulp and 6.5 MWh/t for thermo mechanical pulp production.

Waste paper is used mainly in paperboard packaging and tissue paper manufacture, but utilization in writing and printing papers, especially newsprint after de-inking is increasing.

Waste paper is a very important raw material in developing countries. However, to achieve a high recovery of waste paper, collection has to be improved.

Papermaking

Discharges from papermaking are related to water consumption, performance of the fibre recovery equipment, carry-over of pollutants from the pulp mill, efficiency of the retention of chemical additives and age of the machinery. Small paper mills, frequently using old second-hand machines, discharge large volumes of waste water as a result of both high water consumption and use of outdated machinery.

Discharge of suspended solids is related to water consumption and to the performance of fibre recovery equipment. Closing the mill system does not solve the problem of soluble substances causing BOD load, but reduced water consumption reduces discharge of suspended solids. To implement a closed mill system with reduced water consumption requires good purification of white water and sufficiently large storage tanks.

Savings from reduced water consumption arise as a result of the lower expenditure for fresh water collection and reduced costs for secondary effluent treatment. However, extremely low water consumption causes corrosion and disturbances in the paper chemistry system due to increased content of ions and other undesirable substances.

New retention and drainage aids may increase the capacity of paper machines, which is at present low especially when using straw pulp.

One possibility to improve the final brightness of the paper when using low brightness pulp in the stock preparation is to utilize high brightness filler for example calcium carbonate. This will depend on its local availability. By coating the paper it is also possible to improve the final brightness of the sheet. Coated papers, however, are more difficult to recycle.

Energy conservation in pulp and paper manufacture

Energy conservation is complex involving aspects such as:
- selection of suitable equipment;
- proper design of production line e.g. avoiding over-sizing of pumps, electric motors, drives, etc.;
- optimization of energy distribution; and
- avoiding losses by steam leakage and no-load running of motors, etc.

Energy conservation will also result from the development of new processes and techniques with considerably lower energy demand.

Energy is consumed in the process of removing water from the fibre slurry and fibre mat by filtration, suction by vacuum pressing and by drying. The bulk of the energy is consumed in drying (70 to 80 per cent). The more water that is removed by hydromechanical processes (filtration, suction, pressing) the lower the heat demand for drying and the total energy demand, even if energy consumption in the wet part of the paper machine slightly increases. A good press section is a very important factor in energy conservation. Energy conservation in the drying section is also important. An open paper machine without a hood, or only partially enclosed and without heat recovery, has a substantially higher energy consumption. Different paper grades also have different energy consumption.

BARRIERS

a) **Economic Constraints**

In a modern large scale pulp mill, plant and equipment for combustion of pulping waste black liquor and recovery of chemicals requires about 30 per cent of total investment cost. Modern 'greenfield' mills spend about 20 per cent of total investment costs for environmental protection. These investments are absent in small pulp mills. To implement these cleaner production options would double investment costs when compared with a mill without recovery or biological treatment of effluents.

The pulp and paper industry is capital intensive. A large pulp mill of 200,000 to 300,000 t/a pulp will cost about US $ 340 million to US $ 450 million. Such a mill will meet present environmental norms and will be in a position to adjust to even more stringent ESID norms at the expected level by the year 2000. To finance such a greenfield mill in developing countries requires international financing. Such a mill gives less employment opportunities than small mills. These two barriers may prevent implementation of clean production options for the next 10 to 20 years.

International lending institutions only finance projects which meet their environmental guidelines. This also could be a barrier for small mills until new economically sound technologies for such mills can be developed. To close down a mill because of poor environmental performance could be a social problem for developing countries. A solution could be to transfer pulping capacity from the small pulp mills to large units with recovery systems, and use the small ex-pulp mills for conversion to paper.

Cleaner production options have been developed mainly for large mills and scaling down results in lower efficiency of heat conservation and chemical recovery. It would also increase relative investment cost per tonne of pulp. In China, the budget for a recovery system in a 10,000 t/a mill is estimated to be US $ 4.5 million. In many cases, small mills cannot affort such an investment.

In some countries serious economic barriers to ESID include regulations pertaining to duty on imported equipment, which for paper machinery can reach 40 per cent. Shortage of convertible currency is also a limitation as most modern cleaner production technologies and equipment have to be imported from Europe, North Amercia or Japan.

Price fluctuations of chemicals such as caustic soda and chlorine may act against implementation of cleaner production options. As caustic soda prices increase more rapidly than chlorine, some mills have the tendency to reduce caustic soda charges thus increasing residual lignin content and using more chlorine in bleaching.

It can be concluded that varying raw material properties in developing countries and high investment costs are the main barriers to implementation of clean production options.

b) **Technical Constraints**

In wood pulping almost all stringent limits can be met by implementing modern technology. However, discharges of chlorinated organic compounds from bleaching and malodorous sulphur compound emissions from kraft pulping cannot be reduced by available technology to meet stringent ESID norms. It is expected that by the year 2000, bleaching discharges will be at a sustainable level.

Implementation of modified cooking and oxygen bleaching has an impact on the entire pulping process. Yield is lower in both cases resulting in a higher loading of the recovery boiler as the effluent from oxygen bleaching is recycled and burned. More steam and electricity is produced, but in oxygen pre-bleaching the heat demand is higher as compared with conventional pulping and bleaching. The additional investment for a new mill or a mill undergoing a major expansion is modest. Oxygen bleaching requires a pressurized reactor and additional washing equipment. It is easier to add on to an existing mill, but it will lead to production losses if the recovery boiler or the recausticizing plant are capacity bottlenecks.

The investment costs will be affected by local mill conditions. In a new mill, bleaching can be reduced to three stages instead of five. If enough washing filters are available, costs can be reduced. If 25 to 30 per cent delignification is sufficient a less expensive, hydrostatic, medium consistency, oxygen reactor may be installed. This may be interesting for pre-bleaching of straw and bagasse pulps as these contain less residual lignin and the bleaching sequence may be reduced. Up to this time no straw or bagasse pulp oxygen bleaching is in operation. Another possibility for reducing pollutant discharges from bleaching is adding oxygen to the first alkali extraction stage, which reduces colour and to some extent AOX as well as saving up to 40 per cent of the chlorine dioxide. Oxidative alkaline extraction stages can easily be made as a retrofit installation in existing bleach plants. Installation costs are between US $ 0.5 million to US $ 0.8 million and pay back period is usually six to eighteen months.

In agricultural residues pulping (straw, bagasse), clean production options are more limited due to specific properties of these raw materials e.g. high silica content. In the next decade it will not be possible to reduce BOD and suspended solids discharges as drastically as with wood pulping.

INITIATIVES

Industry

Despite the financial and technical difficulties of implementing cleaner production options the industry has improved its environmental record in many developing countries.

The industry should be further encouraged to use better pulp washing equipment and oxygen bleaching in straw and bagasse pulping.

Government

Government has an important role to play in environmental protection and can bring about changes by issuing environmental standards, enforcing environmental measures, and by offering tax incentives or direct subsidies. The environmental guidelines should be realistically attainable to avoid closing down mills and generating social problems. The tax incentives and direct subsidies should preferably support projects with the greatest potential for minimizing environmental impact.

Government programmes should adopt a progressive approach for existing mills, giving them sufficient time to attain the limits. Furthermore, they should support research institutions in their search for appropriate effluent disposal technologies.

International co-operation

UNIDO and FAO have supported and upgraded research centres and institutes in developing countries. These institutes are conducting research in environmental protection for example: a black liquor desilication process has been developed by the Central Pulp and Paper Research Institute (CPPRI), India, through a UNIDO project; alternatives for black liquor utilization are also being studied in CPPRI through a UNIDO/UNDP project; and a co-operation regional programme (UNIDO/UNDP) is being developed between six Asian Pulp and Paper Research Institutes in order to organize joint research projects, to facilitate technology transfer and set up a network for continuous on-going exchange of information.

Assistance from UNIDO in the following areas are suggested: development of recovery system, adaption of new pulping and bleaching technologies to non-wood raw materials; improvement of washing of non-wood pulp; reduction of fibre losses in existing mills; establishment and strengthening of R & D centres for development of appropriate effluent disposal technologies; energy and water savings in existing mills; assistance for the establishment of pollution control, programmes for existing and new mills; transference of technology between countries through Technical Co-operation between Developing Countries (TCDC), North-South co-operation and human resources development.

Alumina Industry

Case study No. 2

Executive Summary

The Alumina Industry: Overview

Raw material for the worldwide-used Hall Heroult aluminium smelting process is alumina, which is a white crystalline, dustlike material consisting mainly of aluminium oxide. During the last 17 years, the annual amount produced have varied between 30 and 37 million tonnes. Over this same period the industry has shifted from North America and Europe to Australia and Latin America. As of 1989, worldwide there were 69 aluminium plants, with 32 in developing countries.

The shift in production capacity to countries with large bauxite reserves will continue. Practically no expansion can be expected in North America, Europe or Japan and some of their present plants may be closed or converted to produce non-metallurgical alumina. The regions best suited for expansion and new plants are in South America (Brazil and Venezuela), India and Australia, where large bauxite deposits are accompanied by abundant sources of energy, (hydropower in South America, coal in India, coal and natural gas in Australia), required for smelting alumina to primary aluminium.

In the Bayer process, bauxite is digested with hot, strong alkali solution (generally sodium hydroxide) to form a solution of sodium aluminate, and a mud residue (commonly referred to as "red mud"). The amount of red mud varies between 0.3 and 2 tonnes dry residue per tonne of alumina depending on the quality (chemical and mineralogical composition) of the processed bauxite. The annual amount of this waste produced worldwide varies between 30 and 40 million tonnes (calculated as dry material) and constitutes the main environmental hazard of the alumina industry.

Cleaner Production Options

Bauxite Processing

The available Al_2O_3 content of processed bauxites is 98 to 99 per cent and of this 95 to 96 per cent is obtained as product. There is very little scope to further improve these high yields.

Use of Caustic soda and burnt lime

Most of the caustic soda used by alumina plants is bound to the silica content of the bauxite and left in the digestion residue. This cannot be saved by conventional methods. Improved maintenance (better packing, immediate repair of leaking equipment, frequent washing of the floor, etc.) can save 1 or 2 per cent of the caustic soda consumption. Widespread use of recently developed deep thickeners could result in better washing of the red mud.

Burnt lime can be better utilized, if it is of a better quality and if its active CaO content is leached more efficiently. Modern plants usually produce their own burnt lime (this is also an advantage from the environmental point of view, because the lime can be handled in a closed system.

Water

Alumina plants are flexible as far as water consumption is concerned. If necessary they can operate with 2 to 3 m^3 of water per tonne of alumina. Such low consumption figures can only be attained at the cost of a relatively high capital investment (closed water circuits, etc.) and increased maintenance and worker awareness.

Energy use

The possibilities for reducing the harmful environmental emissions resulting from the energy use can be found in two main areas:

(a) the alumina manufacturing process
(b) the energy supply system serving the above process

The primary heat requirement of alumina plants is for calcining precipitated hydrate to alumina. Conventional rotary kilns used 5 GJ/t or more until about 1960. Recently a number of these have been reconstructed by adding cyclones at both ends for better utilization of the heat content of flue gases and calcined alumina. In this way heat demand could be reduced to about 4 GJ/t. At the same time various types of stationary calciners (fluid bed, fluid flash, gas suspension) have been developed with heat consumption of 2.9 to 3.3 GJ/t. Whereas a number of unmodified and modified rotary kilns still operate, and it may be more economic to modify a conventional rotary kiln than to replace it by a stationary one (even though the heat saving is less in this case), it is most probable that the overwhelming part of the calciners operating in the year 2010 will be of the stationary type. This means that a 3 GJ/t primary heat requirement is expected in the long-term.

Some 50 per cent of the electric power required by the process is consumed by centrifugal pumps and about 12 per cent by agitators of various slurry tanks. A significant saving could be achieved by their careful maintenance and operation and by applying up-to-date control systems. It is expected that the average power demand of the alumina plants would drop to about 200 kW.h/t from the present 250 to 300 kW.h/t.

Bauxite residue (red mud). Disposal and Re-use

Up to now about 1 billion (dry) tonnes of red mud has been impounded and this quantity increases by about three to four percent every year. The main constituents of red muds are mostly in the form of non-toxic oxides and silicates. Environmental problems are caused by the large volume of mud, by the alkali content of the liquid phase of the red mud slurry and by the NaOH content. Efforts for reducing the negative environmental effects have been concentrated in the following areas:

(a) Red mud discharge and storage: Development in the field of red mud handling and disposal was rapid between 1980 and 1990. Red mud, leaving the limits of the alumina plant, has two main forms:

- red mud slurry as the final product of multistage washing or of repumping after filtration. Such slurry is dumped into rivers, estuaries, lagoons or into the sea or stored in sealed areas mostly surrounded by dams (generally called 'red mud ponds'), in valleys closed by dams.
- red mud filtered on press, drum or disc filters or concentrated in deep thickeners is transported to the storage area in trucks or pumped after agitation (liquefying) by appropriate pumps.

Storage of filtered and pumped red mud in ponds (dry stacking) is the technology of the 1980s. It is more advantageous than the storage of slurries. Storage of filtered or "deep-thickened red mud" is preferred because of the reduced moisture content, lack of rainwater infiltration, accelerated availability for cultivation and reduced area needed for storage. As compared to wet disposal, the overall projected costs for dry disposal remain marginally less than projected costs for continued wet disposal and the environmental impact is very substantially reduced.

(b) Modifications to the alumina manufacturing process to discharge a residue less harmful to the environment: The sodium aluminium hydrosilicate content of red mud can be partially transformed to calcium aluminium hydrosilicate by the addition of lime during various operations of the Bayer process or as an extra operation connected with it. A part of the chemically bound Na_2O content of the red mud can be recycled and an environmentally less harmful residue is formed with a lower alkali content.

(c) Utilization of red mud in agriculture: Red mud is alkaline with a pH value which changes after a few years. It can be used for improving the fertility of acidic soils. It should not be applied to clay soils since it could lead to chemical imbalance.

(d) Utilization of red mud in industry as an additive: A few examples for the use of red mud are:

- in road construction, for increasing soil strength, or as basic material,
- for crude and fine ceramics,
- for manufacturing light construction and heat insulating materials,
- for cement production,
- as filler in the rubber industry,
- as pigment and for manufacturing paints,
- for manufacturing gas purifying (Lux) mass,
- as an adsorbent and for manufacturing adsorbents,
- for the manufacture of catalysts,
- for manufacturing water purifying and settling agents,
- as an additive to blast furnaces in the steel industry.

(c) Complex waste-free processes for red mud: A number of processes are available for extracting various metals in the form of salts from red mud. Halogen metallurgy has been used for extracting rare metals from previously de-alkalinized red mud. A number of processes intending to utilize not only the iron content but also other useful components (Na_2O, Al_2O_3, TiO_2, V_2O_5, rare metals) of red mud have been developed. Some of them may do this without producing waste. In the course of the process, iron lumps, liquid iron, steel alloys, slag suitable for manufacturing alumina or cement, fertilizer and rare metals can be obtained. The complex waste free processes of red mud processing have the disadvantage that they are very expensive and usually require much more energy than if all products were made of their natural raw materials. The extra energy required would mean added pollution (acid rain, etc.) and increase the threat of global warming. With this in mind the dumping of a relatively harmless by-product (digestion residue), especially if done in an environmentally sustainable manner, seems to be more acceptable.

Waste liquor control

Waste liquors arise from overflow of tanks and alkaline or acidic liquors. Elimination of the former is technically possible through good operating practice. Acidic liquors (mostly wastes after acidic cleaning of digesters, evaporators) have to be neutralized after the cleaning process is finished, and the salt containing solution has to be pumped to the red mud pond.

Dust control

Bauxite dust concentrations should not exceed 2 mg/m^3. Dust protection can be provided by wetting, covering belt conveyors and exhausting the dust to collectors.

Alumina dust is formed in calcining kilns from where it can be separated by the aid of cyclones and electrostatic precipitators, as well as dust collectors.

Stack emission control

Contamination caused by stack gases can be reduced by using cleaner fuels (natural gas instead of coal and fuel oil). In some places this is technically impossible, in others very expensive, and the CO_2 problem would not be eliminated. The proper cleaning of the stack gases is also an economic problem, and some solutions have still to be found (e.g., there is no solution for eliminating the SO_2 content of the flue gas of the calciners, if oil fired).

Barriers

Technical Barriers

The utilization of red mud by other industries is limited. Its relative high water content compared to the natural raw materials for bricks requires the use of more energy. Its utilization in blast furnaces leads to a premature wear-out of their lining, because of the Na_2O content.

Economic Barriers

Although most alumina plants extract practically all the available Al_2O_3 content of processed bauxite, some older ones, especially in developing countries, leave up to 10-15 percent undigested. A more complete digestion would require better facilities (suitable for application of a higher digestion temperature) and more sophisticated process control. Both involve high capital costs (US $ 10 to 100 million depending on the capacity of the plant

The fullscale realization of any of complex waste-free processes for red mud would increase the capital costs of an alumina plant by a factor of 4 to 6. The extraction yield on alumina (and the alumina plant's capacity) could be increased by some 10 to 15 per cent and its caustic soda consumption could be reduced by 30 to 70 per cent. However, the value of the by-products (steel, cement, etc) would only be in the same order of magnitude as that of the alumina itself. The energy consumption of the complex processes would be by a factor of 3 to 5 higher than that of the Bayer process.

As stated above, there is considerable potential for energy conservation. Most of the saving measures, however, require large capital investment. For example, heat exchangers cost millions of US dollars for medium-size alumina plants. Energy efficient processors developed by some major aluminium producers are only available for US 1 to 2 million.

Social and attitudinal barriers

Significant improvements in yield can be attained by better operating techniques involving more frequent chemical analyses. The workforce must be encouraged to apply improved work methods especially laboratory personnel. Where the laboratory is not directly under plant management, there is often insufficient quality control.

Similarly, the use of burnt lime for reducing caustic soda losses (mud causticizing, complex causticizing, etc.) requires special operating and analytical attention. The processes are usually profitable only within a narrow range. Insufficient amounts of lime do not have the expected effect, too much may cause extra alumina losses. Reluctance to pay the required attention to those processes (especially during the afternoon and night shifts) can nullify all positive results of the causticizing.

Quite often social barriers prevent alumina plant improvements. Modern lime burning facilities, even where economic considerations support the investment, cannot be set up because a number of independent small lime-burning plants would go bankrupt and their employees lose their jobs.

Industry Initiatives

Trade associations of the bauxite/alumina/aluminium industries like IBA (International Bauxite Association) and IPAI (International Primary Aluminium Institute) can play a significant role in the exchange of information among the producers, including the field of pollution abatement and environmental protection. IBA's Quarterly News quite often carries articles dealing with environmental problems.

There is also significant potential for dissemination of information, transfer of know-how and technology from the major aluminum companies to their subsidiaries in developing countries.

Government intitiatives

Developing countries rarely adopt strict limits for industrial pollution through lack of information and partly to attract industrial projects, which would be more expensive in developed countries through meeting environmental recommendations. A number of developing countries has already started to consider measures for reduction of pollution caused by various industries and among them alumina plants will also have to comply.

The full impact of suddenly introducing very strict rules for every aspect of their operation (bauxite mining, red mud disposal, stack gases, effluents, etc.) could bring these plants to a halt, especially during periods, when the price of alumina is low. This seems to be the case at present and for the next 5 to 6 years. Such action could lead to the sudden loss of hundreds or even thousands of jobs. In the case of setting up new plants (which will not occur too often during this decade) or significant expansion of old ones the strategy should be to recommend environmental rules prevailing in the developed countries. A compromise for expanded old plants could be an agreement that any pollutant emissions should not increase.

Conclusions

The most promising ways of reducing the negative environmental impact of the alumina industry are the following:

(a) Reduction of the amount of natural resources (primarily energy) consumed per unit amount of alumina manufactured.

(b) Reduction of the residual discharges (effluents, dust, stack gases) per unit amount of alumina manufactured.

(c) Environmentally sustainable discharge and storage of digestion residue (dry stacking of red mud), recultivation of the filled-up storage areas.

The above can be realized by

(a) better operational and maintenance practices (e.g. preventing leakages, proper heat insulation, maintaining the prescribed parameters of the process, etc.).

(b) economically reasonable measures for efficient resource utilization, pollution control and waste disposal (e.g. increasing the number and size of heat exchangers, washing stages, etc.), and

(c) measures necessary to meet environmental requirements conforming with the generic ESID norms (e.g. installing dust collectors, scrubbers, dust filters, red mud filters or deep thickeners, recultivating mined-out areas and filled-up mud disposal areas, etc.) even if costly.

Biotechnology research in Trieste and New Delhi

The International Centre for Genetic Engineering and Biotechnology in Trieste, Italy, and in New Delhi, India, carries out advanced research in biotechnology specially directed at the needs of developing countries and spreads its competence through fellowships and training programmes.

The Centre is funded as a special UNIDO project but is due to become a separate international institution very soon, when a sufficient number of member countries have ratified its statutes.

Biotechnology is seen as one of the mainstays of the technological innovations necessary in order to achieve sustainable development. Not only does it offer a huge potential for alternative, non-polluting processes, it can also supply new and more effective ways to combat pollution and environmental degradation. Access to such new technologies for developing countries is vital, and the ICGEB programme represents an effort to ensure the global dissemination of biotechnological tools and knowhow.

But genetically altered material needs to be strictly controlled and competently handled. If it escapes into fragile ecosystems, it may alter delicate balances. Therefore, UNIDO has collaborated with UNEP, WHO and FAO in the development of a *Voluntary Code of Conduct for the Release of Organisms into the Environment.*

Leather Industry

Case Study No. 3

Executive Summary

INTRODUCTION

The tanning industry is known to be very polluting especially through effluents high in organic and inorganic dissolved and suspended solids content accompanied by propensities for high oxygen demand and containing ptoentially toxic metal salt residues. Disagreeable odour emanating from the decomposition of protein solid waste, presence of hydrogen sulphide, ammonia and volatile organic compounds are normally associated with tanning activities.

The change of flow of international trade in raw material and the substantial relocation of leather production from the developed to the developing countries occurred between the 1960s and the 1980s. In effect this moved the most highly polluting wet processing away from developed countries at a time when environmental regulations were beginning to bite in terms of cost of effluent treatment installations and operation. In many developing countries regulations were non-existent, or if they did exist, they were not strictly imposed. This undesirable situation in developing countries is now changing.

CLEANER PRODUCTION OPTIONS

Water conservation

Water conservation measures lead to lower investment and operating costs. If such a policy is allied to the development of cleaner process technology with the recycling and the recharging of process liquors and the reuse of wastewaters where their influence on earlier processes is innocuous or even moderately beneficial, then there will also be a reduction in the environmental impact of the reduced volumes of liquid, semi-solid and vapour wastes that are emitted.

Modern processing vessels are designed to permit savings in water and chemical usage through their design and internal structure and through the incorporation of controllable drainage and recycling systems and automated chemical dosing and injection systems. Manufacturers of such equipment claim that savings in chemical costs soon cover the cost of these vessels.

Curing hides and skins

In developed countries hides and skins are either sprinkled with 30 to 50 per cent salt on raw (green) weight or they are brine cured by immersion in an agitated saturated salt solution which is maintained at a specified specific gravity in a raceway. In developing countries salt is often too expensive a commodity. Controlled shade drying is the usual method of preservation. Dried hides and skins are often dusted with insecticide. Derivatives of chlorinated aromatic hydrocarbons persist in wastes and are toxic to the environment. They are now prohibited in most European countries. Arsenic and mercury based insecticides are either banned or severely restricted and listed in the International Register of Potentially Toxic Chemicals (IRPTC).

Where a tannery is close to a large abattoir, green hides can be transferred to process without the necessity of temporary preservation.

Alternatively, it is possible to chill hides and thereby preserve them without salt for a few days. It is also possible to preserve raw material for several weeks after irradiation by electron beam or gamma rays. The latter two physical methods are not widely practised.

For developing countries the recommendation is the use of reduced quantities of salt. An application of 15 per cent will still provide six weeks preservation, while 5 per cent salt plus biocide can give two months preservation. For exporting, no long term preservation exists other than drying. Therefore the recommendation is shade drying and sprinkling with the insecticide pybuthrine.

The advantages of low waste preservation are the reduction of salt entering wastewaters from 150 to 200 kg/t down to 20 to 80 kg/t of hide and the absence of toxic insecticides and biocides. But the improvements are at the expense of the reduced effectiveness of preservation, the higher cost of innocuous insecticides and biocides and the need for rapid transportation.

Beamhouse processes

Over 80 per cent of the organic pollution load in BOD_5 terms emanates from the beamhouse; much of it is from degraded hide/skin and hair matter. The beamhouse is the source of all non-limed and limed solid wastes such as fleshings, trimmings and waste split.

In order to prevent degraded keratin from entering effluent streams, hair-saving methods are recommended. This can be done in pits or paddles using less sodium sulphide and mending the liquors instead of disposing of them. Careful analytical control is essential. Removal of hair is then performed by machine.

A drum or paddle process can be adopted using 100 to 200 per cent water and no more than 3.5 g/l sodium sulphide. The hair separates from the stock in solution, thereby avoiding a machine process and the hair is then filtered out by screening.

A succession of baths constitutes the 'Sirolime' process; firstly sodium hydrosulphide to loosen the hair, then sodium chlorate to oxidize the sulphide and finally lime to release the hair into the bath for filtering out.

Throughfeed systems spraying sodium sulphide and other chemicals have not gained wide acceptance, although the repeated use of solutions prevents high COD content in wastewaters.

Unhairing/liming liquors can be recycled after recharging, but swelling tends to reduce with successive cycles and so the fibre structure is insufficiently opened up. Measures such as acidification to pH 4, precipitation and separation of organic matter, collecting of hydrogen sulphide and reabsorption in caustic soda have been tried, but a better method is the separation of unhairing and liming.

In this method the sulphide unhairing liquor is recharged after filtration. The pelt is thoroughly washed and the waste wash liquor used for soaking hides. The pelt is limed with an addition of 0.1 to 0.3 per cent sodium hydroxide to control the swelling. This lime liquor can be reused after recharging. Over a 20 day period, sulphide can be reduced by 80 per

cent, lime by 93 per cent, COD by 17 per cent and BOD_5 by 15 per cent in the wastewater compared with conventional liming.

Sulphide-free processing is possible but not widely practised. The most promising method is enzyme unhairing using proteolytic enzymes. For skins this can be accomplished overnight, but for hides it requires 1-2 days and is usually only 80 to 90 per cent effective, requiring a liming with sodium sulphide for 4 to 6 h afterwards. In any event, liming must follow enzyme unhairing in order to swell the pelt. Lime liquors can be recycled and all hair is retained.

The latest development in this field is the pressure injection of enzyme solution. This technology is still at an early stage.

For developing countries the recommendation for hides is the separation of unhairing and liming stages. Both liquors can be recharged and hair screened out. The intermediate wash can be reused as a soak liquor. Enzyme methods could be developed for skins. The clear advantages are reduced pollution load and reduced use of chemicals. The organic load emanating from the beamhouse can be reduced by 60 per cent. The use of enzymes can lead to the production of leather with cleaner and finer grains with less grain shrinkage. The commercialization of hair as a by-product offers a potential economic return. But all this has to be balanced with the need for recirculation equipment, screens, unhairing machines, the greater cost of specialty chemicals (especially enzymes), the capital, maintenance and technical control costs and the longer process times enforcing the capital cost of more work in process.

Tanyard Processes

Low chrome systems using only 5 to 6 per cent chromium sulphate require a pretannage, possibly using an aluminium salt. This approach has the advantage of producing a pretanned leather in a wet white condition rather than wet blue. In this condition the leather can be split and shaved, thereby eliminating chrome from waste split and shavings. The leather can be stored in this condition for up to six months and can be traded as a semi-processed leather. Aluminium in effluent and solid wastes, however, is not without its problems as aluminium is known to be more poisonous to aquatic life that trivalent and even hexavalent chromiums under certain conditions.

High exhaustion systems or reuse (recovery and recycle) systems are probably more realistic that the change to alternative tanning materials.

The principal concern is that, in the environment, trivalent chromium will oxidise into its hexavalent form. If such oxidation occurs under natural conditions it is reversible.

Alternative mineral salts such as aluminium, zirconium, titanium and iron are possible substitutes for chromium salts. Basic aluminium chlorides, sodium aluminium silicates and zirconium sulphates have definite value as retanning materials at the stage, following the main tannage, when different tanning materials are applied in order to confer the desired final character to the leather.

High chrome exhaustion systems coupled with a reuse system offers the best route to reducing the pollution load from the tanyard.

The obvious advantages of these process modifications and reuse systems are increased utilization of chromium and a consequent saving on chemical costs and effluent treatment cost. The drawbacks are the expenditure on sophisticated chemicals, special equipment for screening, filtering, precipitation and circulation and monitoring equipment for precise technical control.

Recommendations concerning chrome tannage for the future could be for a replacement of chrome at least in the first phase of tanning.

Alternative vegetable tanning methods are closed systems which ensure high utilization of material. The 'Liritan' process developed in South Africa consists of a pit pretannage for two days using polyphosphate and sulphuric acid until penetrated, followed by a pit pretannage for two days in weak veg liquor, followed by three days in a counter current system at 35°C and then finishing off in a drum at 40°C with a 45 per cent tan offer. This process takes 12 days and utilizes 97 per cent of the tan applied.

The advantages of such processes are high chemical uptake, low pollution load, uniform penetration of the veg tan and shortened process time with consequent financial efficiency. Again, a disadvantage is the necessity of careful technical control.

Finishing

Conventional finishing comprises all or a selection of the following: colour spray, applying colour to undyed leather or adjustment to the dyed colour of leather using dye dissolved in solvent; grain impregnation with a polymeric dispersion diluted in solvent to penetrate and improve the firmness and smoothness of the surface - acrylates are most commonly used; base coat, consisting of a polyacrylate, polybutadiene or polyurethane binder with pigments and auxiliaries to ensure good surface colour and adhesion; if the leather is semi-aniline an effect colour is sprayed; final coat, consisting of a nitrocellulose or polyurethane lacquer.

There is a need to eliminate hazardous crosslinking agents used to improve abrasion and rub resistances in acrylic and polyurethane dispersions.

It would be quite feasible for tanneries in developing countries to apply aqueous finishes for base and middle finish coats and to apply aqueous nitrocellulose with polyurethane or polyacrylate top coats. Environment-friendly crosslinking agents or self-crosslinking reactive polymers could also be incorporated. Roll coating does not offer insurmountable technical problems. Benefits are felt from the reduction of VOCs in the workplace and financial savings accrue from the adoption of roll coating. The disadvantages are higher chemical costs and changes in the physical properties of finishes, which can be compensated by judicious reformulation of finishes.

BARRIERS

Economic barriers

The cost of introducing a cleaner processing method may be prohibitive and beyond the reach of a small scale tanner: the price of the special drum

for hair save unhairing with the necessary auxiliary equipment may be as much as twice that of the conventional drum. Enzyme unhairing needs very accurate control and consistency of all parameters (pH, temperature, float, etc.) which is possible to achieve only in rather sophisticated tanneries and is associated with higher production costs (partly off-set by lower wastewater treatment expenses). High chrome exhaustion tanning requires very expensive specialty chemicals, normally proprietary products.

In the industrialized countries the leather industry has had to suffer economic constraints but these are not as onerous as in developing countries. Interest rates on borrowed capital are frequently much higher. As the industry has advanced to greater production of finished leather, the amount of capital tied up in work-in-progress has increased along with the necessity to keep higher inventories of chemicals, machinery spares, etc. Because of problems with poor infrastructure in many developing countries, the tanneries have always kept higher stocks of chemicals than their counterparts in developed countries, against the contingency of delays in delivery from ports. Another disadvantage is the imposition of import duties on chemicals and machinery. Few specialty chemicals for tanning are produced in developing countries, although basic chemicals such as salt, lime, sulphuric acid, sodium sulphate or sodium carbonate may be available indigenously. Most tanning materials, dyes, fat liquors, special auxiliaries and finishes need to be imported. Duties depend on government policy and they can range from zero to over 100 per cent.

Cost of plant and chemicals for treating effluent can be another heavy cost. While tanners in developing countries may be shielded from raw material market fluctuations through market protection policies and while they may benefit from fiscal incentives in their operation, tanners in developed countries do not need to carry high inventories nor do they suffer the often inordinately high cost of capital or the inflation rates of many developing countries.

Thus relative advantages in the various locii of manufacturing may balance out. Tanners in developed countries have either invested in effluent treatment or opted to concentrate on processing semi-processed material purchased domestically or from abroad. Translated into dollars per square foot the on-cost of effluent treatment in 1987 in the following countries was:-

Hungary	2.8 - 3.5 cents per ft² [1]
Italy	7.7 - 10.3 cents per ft²
U.K.	8.3 - 10.0 cents per ft²
Germany	8.1 - 10.0 cents per ft²

Initial treatment costs may not result in this level of on-cost in developing countries, but as standards become more stringent they will inevitably increase. Such additional cost could tip the economic balance in favour of processing in developed countries. In fact some developing countries already import wet blue and crust leathers from specially developed plants in developed countries.

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[1] (1 ft = 9.29 cm²)

Inadequate legislation and lack of monitoring facilities

Pollutant discharge standards in most developing countries are by nature rigid and have a disregard for specific site conditions. Instead of a gradual approach as called for which would phase installation of treatment facilities (for example the physico-chemical first followed by the biological treatment and appropriate sludge handling) a tanner is under pressure to set up a complete treatment system and meet all discharge limitations at once which is beyond his financial and technical means.

In addition to the regular process and quality control, tannery laboratories must be able to measure the following specific pollution parameters: pH, suspended solids, total dissolved solids, sulphide, ammonia nitrogen, chromium, aluminium, phenols, VOCs and CODs; larger plants should also be able to measure the biochemical oxygen demand (BOD_5) and thus establish the ratio of COD to BOD_5 which can be used as an indicator of biodegradability.

However, very few tanners have the necessary process and effluent treatment control facilities and legislation enforcement agencies usually lack skilled personnel to monitor performance of the installed treatment plants.

Social considerations

Tanning is a traditional industry. In many developing countries it is carried out by a certain sector of society. Simply tanned leathers are produced for local craftsmen to manufacture into leather products for local markets. Methods of tanning and fabrication of goods are far removed from modern methods. Such segments of society are difficult to bring within the modern framework of production and emission control. Governments often feel inhibited in dealing with such problems because of the social and even political upheaval that would occur. The problem is further exacerbated in some countries where tanners are traditionally regarded as socially inferior because of the nature of their work. These groups, because of traditional discrimination, have amassed considerable political privileges. Consequently there are difficulties in altering the structure of artisan industry.

The adoption of low waste technology often requires a radical alteration of most tannery processes while, at the same time, ensuring that the ultimate product retains its marketable properties. Therefore if a tanner is producing consistent quality of leather which satisfies his customers using a process which may be wasteful in water, energy and chemical utilization, he may resist altering his operations to comply with environmental demands.

Industrialized tanners in some developing countries, who face the enforcement of emission regulations, are in some instances contracting their wet work processing to artisan tanners who continue to operate without restrictions.

Industry initiatives

Tanners in developing countries can begin by adopting good housekeeping measures which require little or no capital investment, such as water conservation at all stages of wet processing. Savings in chemicals by introducing reuse-recovery-recycle systems can pay for the simple equipment needed to run them, such as collection pits, pipes and pumps. Tanners in

developing countries can reduce the pollution load by pursuing low waste technologies. This will, in effect reduce the amount of capital investment that will be required in the treatment of effluent through a reduction in the size of facility needed. By limiting pollutants in the streams, the quantities of effluent treatment chemicals will be commensurately limited. Tanneries should also maximize their returns on residues from sludge and solid wastes; investigating the feasibility of extracting methane, saving hair for conversion into felt; turning waste split and untanned trimmings into gelatine, protein powders and collagen for sausage casings and medical and surgical films; turning fleshings into glue, animal feed protein and fertilizers and tanned waste into leatherboard, filter media, non-wovens and other end uses. By commercializing solid wastes, the cost of effluent treatment can, to some extent, be covered.

Conventional tanneries should be expected to tighten-up on the accuracy of their operations to prevent wasting resources, chemicals and water and to avoid these becoming sources of pollution; introduction of modern production control systems should be encouraged.

Biogas can be recovered by the anaerobic digestion of sludge. Biomethanization reduces the volume of the sludge and improves its stability and thereby yields a material more acceptable to landfill. However, owing to the presence of some toxic and corrosive components the biogas produced has to be purified before use.

Solid wastes can be a useful source of chemicals and protein. For instance it is possible to recover chromium from chrome leather shavings and waste by enzymatic hydrolysis. Leatherboard can be produced from vegetable tanned shaving and trimmings. It is also possible to use chrome tanned waste, although the quality of the leatherboard is not as high.

Untanned trimmings have long been a traditional source of gelatin and untanned fleshings, a source of glue. Tallow and grease can be obtained from fleshings by rendering. Perhaps the most interesting developments in recent years have been those that have highlighted the possibility of producing protein suitable for animal and fish feeds from solid wastes. They can be used alone or in combination with soya and/or synthetic amino acids to supplement the deficiencies in collagen.

Flesh splits can be converted into collagen sausage casings. Collagen dispersions can be coagulated with natural and synthetic rubber latices to give low density rubber shoe soling material. Collagen can be incorporated in coating materials, in pharmaceutical applications, as an absorbant material for filtering sulphur dioxide and other air pollutants. Protein hydrolysates can be applied in the manufacture of cosmetics. They can also revert to the leather industry, being incorporated at the pretanning stage and contributing to the subsequent better uptake of tanning materials.

Work on alternative uses of collagen is being carried out in several countries and points to the serious concern of making practical and commercial use of chemicals, fats and protein that would otherwise be wasted through dumped trimmings, shavings and waste split.

A phased approach to installing effluent treatment plants, i.e. physico-chemical (primary) followed by biological (secondary) treatment optimized on

the basis of actual performance of the primary system is considered advantageous.

Joint effluent treatment plants are very often the best solution for tannery clusters (as a rule consisting of small and medium-scale type units) so typical for this region; combined with domestic waste they offer technical advantages with an economy of scale. However, in view of the lack of experience in designing and operating such systems, the installation of demonstration plants, preferably on an industrial scale, is very much needed.

Information and training programmes have to facilitate a better understanding of the linkage between production and treatment, monitoring of equipment in the case of breakdowns and the changes of effluent composition as well as handling of hazardous chemicals and by-products.

Advanced treatment systems can be tailored to specific circumstances and the quality of effluent required. These systems are expensive and require expert control. It is advisable to alter processes and chemicals utilized and thereby avoid the costly sophistication of such methods as:

- high performance aeration
- nitrification/denitrification
- high efficiency filtration
- carbon filtration to remove pesticides and other organic materials
- reverse osmosis (to reclaim water).

Inevitably there must be effluent requiring treatment and this must comply with local regulations on emissions. It should also be stressed that every tanner's emission problems are individual, there is no standard tannery effluent. This reflects both the great diversity of leather production and the fact that the raw material itself is not uniform. Thus every tannery's effluent treatment requirements need to be evaluated individually, not only according to the processes being employed and the type of raw material being processed, but also according to the location of the tannery, the volumes of water being used and emitted and the direction of the emissions (surface waters, sewers etc.).

In the future the search will proceed for tanning materials that can realistically replace chromium, unhairing systems that are efficient and do not rely on sulphides, deliming methods that do not require ammonium salts and vast reductions in emission of VOCs through elimination of solvents in fishing.

International Co-operation

The need for an easily accessible source of information on clean technologies inspired the British Leather Confederation, which provides the Secretariat for the International Union of Leather Technologists and Chemists' Environment and Waste Commission to gather information in co-operation with six other leather research institutes. The work is dependent upon the development of a network of co-operation and support, involving tanners, industrial research centres, industry suppliers, the Government and other agencies (e.g. the European Commission under the SPRINT programme, the United Nations Environment Programme etc.) and independent leather experts. Tanners

through their trade or R & D associations in developing countries would be wise to become involved with this programme.

The main objective is to set up a practically useful system to enable the tanner to easily shortlist appropriate technologies for his requirements from the database. For the practising tanner there is a world of difference between results claimed by an R & D centre or a chemical supplier and what happens in reality. Not only may the technology be suspect, but differences in the costs of chemicals and/or energy can have a significant impact on process economies in different countries. This aspect is particularly relevant as regulatory agencies, or consultants working for them frequently scour the technical literature without ascertaining the true status of the technology they may be imposing.

It is considered most important that the database should not just be a bibliographic source of information but should be of immediate practical use, quantifying, wherever possible, the reduction in pollution achievable by clean technology, listing any disadvantages and, above all, giving an indication of its present level of development and extent of use, since systems inevitably range from those just at the research and development stage to well established technologies in widespread use.

Co-operation between government and industry and involvement of R & D organisations from developed countries in environmental projects carried out in developing countries could be evolved in many countries, given the willingness for co-operation between industry and governments and the financial help and incentives from the Government.

UNIDO's role

During the last few years pollution control has taken a very prominent role in UNIDO's technical assistance to the leather and leather products industry so that at present there is virtually no project in the tanning sector without an environmental component.

As a rule, cleaner and low waste technology and end-of-pipe treatment issues are simultaneously addressed. Advice in defining, monitoring and enforcement of emission standards is also given as required.

Assistance is extended both to individual industrial plants or agglomerations of tanneries and to leather R & D establishments. As a matter of policy, any assistance to leather R & D and training centres includes installation of a pilot and demonstration plant for treatment of tannery wastes as until recently none of the centres in developing countries had such facilities. They are encouraged to expand pollution control component in their training programmes and strengthen their capabilities in designing tannery effluent treatment plants.

Dissemination of information on environmental protection is another important area of UNIDO activities in the leather sector.

Phosphate Fertilizers

Case study No. 4

Executive Summary

I. OVERVIEW

Today, the world's phosphate fertilizer industry produces about 41 million tonnes of P_2O_5 annually not including that used for animal feed supplements (about 1.8 million tonnes P_2O_5) and other industrial purposes (about 2 million tonnes P_2O_5). Almost 40% of the current annual production of approximately 41 million tonnes P2O5 as finished products is in the form of ammonium phosphates (DAP and MAP), and a further 13% is produced as TSP. This production accounts for approximately 83% of the phosphoric acid used in fertilizer production. These data for 1988 are summarized below.

Product Type	P_2O_5 (thousand tonnes)	Percent of Total P2O5	Percent of Total Phosphoric Acid Use
DAP[1]/MAP[2]	16,235	39.2	62.2
TSP[3]	5,507	13.3	21.1
Phosphoric acid-based NPKs[4]	4,338	10.5	
Nitric acid-based NPKs	3,879	9.4	16.6
SSP[5]	7,083	17.1	
Other phosphate fertilizers	2,888	7.0	
Direct application phosphate rock	1,310	3.2	
Basic slag	205	0.5	
TOTAL[a]	41,445	100.0	100.0

a. Totals may not add due to rounding.

(1) Diammonium Phosphate (DAP)
(2) Monoammonium Phosphate (MAP)
(3) Triple Superphosphate (TSP)
(4) Nitrogen Phosphate Potassium (NPK)
(5) Single Superphosphate (SSP)

Two-thirds of total production occurred in the United States, U.S.S.R., China, and Western Europe. Production derived from phosphoric acid varies from around 80% or more in North and Central America, North Africa, and West and South Asia to around 50%-60% in other regions, except Oceania and China where phosphoric acid contributes only about 14% and 1% of the P_2O_5, respectively.

II. RESOURCES

Phosphate rock concentrate

The annual production of 41 million tonnes of fertilizer P_2O_5 requires the mining of about 650 million tonnes of ore. This ore is processed into about 140 million tonnes of phosphate rock concentrate having a typical P_2O_5 content of about 31% for the sedimentary material; the P_2O_5 content of concentrate derived from some igneous ores may exceed 36%. An additional 15-20 million tonnes of phosphate rock

concentrate is used annually for nonfertilizer purposes. In 1989, total production of phosphate concentrate amounted to about 163 million tonnes. Although 34 countries currently produce phosphate concentrate, only four countries (United States of America, U.S.S.R., Morocco, and China) account for about 75% of all production.

Sulphur

The second major raw material required for phosphate fertilizer production is sulphur. Annual world production of sulphur in all forms has increased from 52 million tonnes in 1975 to almost 61 million tonnes today. Almost half (29 million tonnes) is used for the manufacture of phosphate fertilizers, and an additional 4.3 million tonnes is used for the production of other fertilizers such as ammonium sulphate. All but 8% of the total production of sulphur/sulphur equivalent is used to manufacture sulphuric acid.

III. PROCESSES:

Phosphoric acid is the major intermediate used to produce phosphate fertilizer. Approximately 70% of all fertilizer P_2O_5 is derived directly from wet-process phosphoric acid. Most of the balance is derived from phosphate concentrate that is usually treated with phosphoric or other acids (sulphuric or nitric acid) to increase its solubility.

The degree of potential environmental impact is very process- and site-specific. The main possibilities include the following:

- Disturbance of land used for phosphogypsum and contaminated process water storage.
- Contamination of water resources caused by the disposal of phosphogypsum and its associated process water, including acidity, dissolved metals, and radionuclides.
- Fluoride emissions to the atmosphere from the phosphoric acid process.
- Escape of radionuclides that may be harmful to human health.
- Airborne solid and liquid particulates including those caused by wind erosion of phosphogypsum stacks.
- Release of contaminated cooling water, plant site stormwater drainage, and boiler blowdown residue.
- Release of metals and other residues from the regeneration or disposal of spent catalyst from sulphuric acid production units.
- Release of solvents, oils, and other contaminants from plant maintenance and workshop activities.

Phosphate mining

Phosphate concentrate is derived from naturally occurring phosphate-bearing ore. Typically, the naturally occurring ore contains 15%-30% P_2O_5 comingled with sand, clay, and other impurities. Current world phosphate reserves amount to the equivalent of about 12 billion tonnes of marketable concentrate, and the reserve base amounts to more than 30 billion tonnes.

The great majority of phosphate ore is obtained using surface mining techniques. This requires the removal and eventual replacement and reshaping of as much as 5 tonnes of overburden per tonne of ore, or several times that amount of material per tonne of recovered P_2O_5 because not all the P_2O_5 contained in the mined ore is recovered as a marketable phosphate concentrate. Depending upon the characteristics of the ore, as much as one-third of the P_2O_5 can be lost in the process of separating the phosphate from its parent ore consisting of sand, clay, limestone, and other materials. The separation (beneficiation) process ranges from crude dry-screening to washing, wet screening, magnetic separation, hydraulic separation, centrifugation, flotation, calcination, settling/decantation, and drying.

Metallic constituents of phosphate ore, most notably cadmium, have received a great deal of attention in recent years, especially regarding international trade of phosphate concentrate containing elevated levels of cadmium. Techniques for removing cadmium from phosphate concentrate, for example, high-temperature calcination, have been evaluated and used to a limited commercial extent with generally unsuccessful and costly results. Removal of cadmium and other metals to tolerable levels from phosphoric acid seems to offer more promise. Such removal techniques, though currently not practiced commercially in the fertilizer industry, involve ion-exchange or solvent extraction methods.

Phosphogypsum

Each tonne of P_2O_5, produced as wet-process phosphoric acid, results in the production of about 5 tonnes (dry basis) of phosphogypsum and often about twice that amount of process water.

In some cases, phosphogypsum is slurried with seawater and discharged to the sea beyond the low-tide beach. In other cases, it is discharged into rivers or integrated with mine reclamation projects where it is buried in mined-out areas.

The technology for conversion of phosphogypsum to sulphuric acid, aggregate, and other useful products has been relatively well developed, but its commercial adoption is constrained primarily by economic factors. The integration of wet-process phosphoric acid production with coal-fired electric power production could result in the almost total utilization of phosphogypsum in the form of recovered sulphur dioxide for the production of sulphuric acid and lime for the production of cement.

The main technical obstacle to the replacement of natural gypsum by phosphygypsum is the impurities contained in the latter which are passed on from the phosphate ore during H_3PO_4 production. These are entrained phosphoric acid, unreacted phosphate ore, fluoride compounds, cadmium and other heavy metals, and naturally occurring radioactive substances.

Where naturally occurring gypsum is available or where pure gypsum is available from other manufacturing sources, it is improbable that crude phosphogypsum can ever be competitive for any useful purpose. It is clear that, notwithstanding possible processes for the re-use of phosphogypsum, by far the greater part of production will continue to be stored on land or disposed of to the sea in the foreseeable future.

Possible areas of phosphogypsum use are: production of cement and lime, production of sulphuric acid, construction materials, in agriculture and as a pigment for the paper industry. Although the quantities used for these purposes are relatively small and usually account for only a minor proportion of phosphogypsum production, there may be some room for their further development. Phosphogypsum is used in the manufacture of cement in Bulgaria, Czechoslovakia, Greece, Indonesia, Sweden and Turkey. It is used in the production of H_2SO_4, cement and lime in Austria and Poland. It is used in the production of construction materials in France, the Federal Republic of Germany, Japan, Spain and Sweden. It is used in agriculture in France, Greece, Spain, the United Kingdom and the United States. It is used as a paper pigment in Finland.

Under specific soil and climatic conditions, it may be possible to use more phosphogypsum in agriculture and in the production of construction materials in those countries which do not possess natural gypsum deposits.

Further small quantities of phosphogypsum may be used as a pigment in the paper industry. The production method of such a pigment has been developed in Finland, based on high quality phosphogypsum produced from magmatic phosphate ores.

Recirculated process water

Recirculated process water is used to slurry phosphogypsum and transport it to the disposal site. It is also used to remove heat and gaseous and particulate effluents from the wet-process phosphoric acid concentration unit and the finished product processing units. The acidic process water, referred to as process wastewater by the U.S.-EPA, dissolves and holds in solution a number of metallic elements originally contained in the phosphate rock. Also, slippage of phosphoric acid to the phosphogypsum during filtration, and the collection of particulate from other processing units, adds to the water small quantities of solubilized metallic ions in addition to phosphorus, sulphur, and fluorides. Furthermore, because the process water is recirculated on a closed-loop in an effort to obtain a zero-discharge mode of operation, the concentration of these dissolved species increases quite markedly with time.

IV. ALTERNATIVE PRODUCTS

Many factors affect the response of a crop to water-soluble phosphorus; however, minimum levels of water-soluble phosphorus needed for certain crops can be estimated. Although this is a subjective judgement, the water-solubility seldom needs to be as high as currently found in most commercial phosphate fertilizers. For most crops, 40%-60% of the total phosphorus in the water-soluble form is considered adequate provided that most of the remainder is "available" as measured by conventional laboratory test methods. For short-season vegetable crops, the water solubility should be higher; for longer season crops, it can be lower. Most vegetable crops are grown over a fairly short period of time with root systems that are not well developed, whereas long-season crops are characterized by well-developed root systems. Because the phosphorus is quite immobile in the soil, a large and vigorous root system is more likely to intercept and absorb phosphorus from the soil.

Irrigated agriculture, which accounts for about 25% (about 240 million ha) of the current world total harvested crop area may require special fertilizer materials to facilitate application. Flooding and overhead sprinkling account for the majority of irrigated agriculture, with flooding and furrow water application techniques being the most common, representing about 90% of the total. Currently, drip-type irrigation systems account for less than 1% of the total, but the application of such systems is increasing. In general, if the fertilizer is not applied with the irrigation water, phosphate fertilizer products and application methods used for upland agriculture are appropriate for irrigated agriculture.

In summary, from an agronomic point of view, the production of highly water-soluble phosphate fertilizers is not necessary for the majority of cropping systems. A more moderately water-soluble family of phosphate fertilizers with less dependence upon wet-process phosphoric acid would be appropriate in most cases.

V. POLLUTION ABATEMENT

Comparative Cost of Phosphate Products Including Estimated Incremental Cost of Environmental Compliance

Except for limited opportunities for industrial integration designed to utilize process wastes, technological innovations in the phosphate industry seem to offer little scope for significantly decreasing the quantity of basic process wastes encountered, e.g., phosphatic clay material, phosphogypsum, and process water. Thus, the costs for pollution abatement were estimated according to a scenario which assumes current available technology and relatively stringent regulatory requirements currently under examination in the United States of America. The following range of industry average incremental costs for environmental compliance is indicated:

Cost Component	Estimated Cost
- phosphate mining and land reclamation	US $ 1-5/tonne*
- phosphogypsum management	
- active stacks	US $ 6-8/tonne*
closed stacks	US $ 5-20/tonne*
- process water management	US $ 22-70/tonne*
- finished product processing	no change
Total:	US$ 34-175/tonne*

* US $/tonne P_2O_5 as wet-process phosphatic acid produced over assumed project life at an annual production of 10 million tonnes P_2O_5.

The large variability in estimated costs is due to a number of site-specific technical and regulatory factors, variations in the assumed capital recovery period, and the lack of a broad base of actual cost experience relative to the scenario examined.

Estimated Impact of Product Choices on the Delivered Cost of Phosphate Fertilizer

The estimated and incremental environmental compliance costs for phosphogypsum disposal described for the United States scenario were adjusted downward by US $20/tonne P_2O_5 for non-U.S. phosphoric acid producers. This was done to correct for the cost of closing inactive phosphogypsum stacks which is more likely to be the case in the United States than elsewhere.

The cost of international and domestic transport and marketing was estimated. Also, because some phosphate products contain nitrogen and/or sulphur, these nutrients were credited on a farm-level cost basis of US $520/tonne for nitrogen and US $135/tonne for sulphur to arrive at a net delivered cost for P_2O_5 at the farm level. For compound NPK products, all calculations were made on a net P_2O_5 basis to avoid the complexity of determining credits for other nutrients commonly contained in NPKs.

Using the upper end of the estimated compliance cost range, the estimated incremental cost of environmental compliance (world weighted-average basis) at the farm level varies from US $4/tonne P_2O_5 (direct application phosphate rock and SSP) to US $169/tonne P_2O_5 (DAP) as shown in the following table. The net cost of P_2O_5 delivered at the farm level, including the environmental compliance cost, varies from US $376/tonne P_2O_5 for direct application phosphate rock to US $720/tonne P205 for DAP and US $757/tonne P_2O_5 for TSP. These costs not only reflect the estimated cost of environmental compliance, but also the higher cost of production in new facilities, which is caused by higher capital charges than currently experienced by the established industry. The favorable position of the existing industry with its relatively low capital charges is clearly illustrated.

ESTIMATED WORLD AVERAGE DELIVERED COST OF P_2O_5 AT THE FARM LEVEL INCLUDING INCREMENTAL COST OF ENVIRONMENTAL COMPLIANCE - NEW AND EXISTING PRODUCTION FACILITIES

	NEW PRODUCTION FACILITIES		EXISTING PRODUCTION FACILITIES DELIVERED COST AT FARM LEVEL USING AVERAGE 1990 F.O.B. PRICES[A]	
PRODUCT	INCREMENTAL COST OF ENV. COMPL.[B] (US $/T P_2O_5)	DELIVERED COST AT FARM LEVEL (US $/T P_2O_5)	WITH ENV. COMPL. (US $/T P_2O_5)	WITHOUT ENV. COMPL. (US $/T P_2O_5)
DIRECT APPLICATION PHOSPHATE ROCK	4	376	-	-
COMPOUND NPKs[C]	83	656	-	-
SSP	4	686	-	-
DAP	169	720	492	323
TSP	127	757	560	433

A. BASED ON AVERAGE 1990 U.S. GULF COAST F.O.B. PRICES PLUS US $ 70/TONNE PRODUCT TO COVER TRANSPORTATION, BAGGING, AND MARKETING COSTS. DAP IS GIVEN CREDIT FOR ITS NITROGEN CONTENT AT US $ 520/TONNE NITROGEN DELIVERED AT FARM LEVEL.

B. ENVIRONMENTAL COMPLIANCE

C. NPKs ASSUMED TO CONTAIN 15% P_2O_5

The agronomic suitability of phosphate fertilizer products containing lower levels of water-soluble P_2O_5, for example, 40%-60%, may offer significant economic advantages other than those related directly to mitigating the cost of environmental compliance, including the following:

1. The use of lower grade phosphate rock to produce conventional products, such as DAP, TSP, and SSP, containing lower levels of water-soluble P_2O_5, would extend the useful life of existing mines and production facilities.
2. Less soluble products would help to expand the regional and global phosphate resource base to include phosphate ores containing higher levels of impurities.
3. Less soluble products would tend to decrease the environmental impact at the production site because less intensive beneficiation would be required.
4. Under some soil/crop/climatic conditions the use of less soluble products would improve the agronomic performance of the applied phosphate fertilizer.

Relating Delivered Cost of Phosphate Fertilizer to Agronomic (Solubility) Needs

DAP, even with its relatively high estimated cost for environmental compliance compared with alternative products, ranks very favorably among the phosphate product choices from the point of view of delivered cost. Although SSP and some NPKs may effectively deliver P_2O_5 to the farm level at a net cost slightly below that of DAP (in the order of 5%-10%), it would not be practical or cost effective in many cases to assume that the total P_2O_5 requirements could be effectively supplied in the form of SSP or NPKs that usually contain only about 15%-20% P_2O_5.

It is interesting to note that TSP, with an estimated environmental compliance cost of about 70% that of DAP, still remains less attractive on a delivered P_2O_5 basis than DAP. This, of course, is due to the extra value placed on DAP (US $94/tonne DAP) for its nitrogen content.

Direct application phosphate rock is, of course, the least-cost form of P_2O_5. Its delivered cost (P_2O_5 basis) at the farm level is about 52% that of P_2O_5 derived from DAP, according to the assumptions used for this evaluation. The widespread use of direct application phosphate rock as a source of P_2O_5 is severely limited for agronomic reasons as well as by the lack of general availability of suitably reactive material.

VI. BARRIERS TO CHANGE AND INITIATIVES REQUIRED TO BRING ABOUT CHANGE

Lack of Definition of Acceptable Environmental Standards

There is currently no universal definition or criteria for objectively judging the "environmental acceptability" of a fertilizer production or use practice. The criteria for an "acceptable standard" may vary widely depending upon climatic, geological, and other technical and nontechnical factors including population density and public pressures.

It seems desirable for the global industry to agree upon scientifically established minimum environmental standards appropriate to given locations. It is therefore appropriate that international and national industry agencies, together with national environmental regulatory agencies, convene to establish and agree upon minimal standards for environmental compliance in the phosphate industry. Additional compliance standards for national industries, where deemed necessary or desirable, could be resolved on a national or local level.

Cost Required to Implement Available Technology

The widespread implementation of the available technology required to mitigate certain environmental concerns is, however, severely constrained by cost-related market factors. If, for instance some the proposed environmental standards were adopted globally, the annual total industry cost for compliance might be in the order of US$4.0 billion. Because of the industry structure, environmental benefits will accrue to a limited number of countries where strict compliance is observed, but the costs will be incurred globally.

Lack of profitability in the private sector, and inertia in the public sector in many countries, will preclude or delay enforcement of any agreed-upon minimum standards. It is therefore appropriate that acceptance of minimum industry standards should be coupled with international agreement on an implementation timetable for compliance. With the concentration of production in only a few countries and the preponderance of public-sector ownership of the production resources, a significant level of international cooperation may be an achievable goal.

Major Investments Required to Change Product Mix

The farm-level cost of P_2O_5 derived from direct application phosphate rock, SSP, and some NPKs would be least affected by increased environmental compliance costs at the production site. However, the industry would have to undergo a major restructuring to meet the world's P_2O_5 demand with these products. Not only would such a restructuring to change the product mix require large investments in new and modified production and distribution facilities, but the increased cost of distribution would offset most of the environmentally related production cost advantages.

In some countries, the current viability of existing or proposed SSP, NPK, and direct application phosphate rock production units is questionable because the more concentrated DAP and TSP products offer economic advantages even though they are imported. Given adoption of increased environmental compliance costs for the more concentrated phosphoric acid-based products, the viability of production units that do not depend upon phosphoric acid will be improved. Under certain conditions, such plants will be more cost effective in supplying local markets when compared with DAP or TSP. This would provide increased opportunities for exploiting indigenous phosphate resources for serving selected local markets.

Limited Availability of Foreign Exchange

Compliance with many of the proposed environmental standards will require large investments at the production facilities and thus increase the cost of

phosphate fertilizer at all levels. In many cases, the foreign exchange required to finance the necessary investments and/or fertilizer raw material and finished product imports is expected to be lacking. This constraint will be especially critical in those resource-poor countries that depend heavily upon imported raw materials and finished phosphate fertilizers.

Marginal Competitive Status Within the Phosphate Fertilizer Industry

The generally depressed state of the phosphate fertilizer industry, with its overcapacity, high capital investment, low returns, and intense competition between the major phosphate-surplus countries, is not conducive to increases in investments and production costs related to compliance. This dictates that least-cost approaches be taken.

Lack of Significant Farm-Level Cost Differences

The farm-level P^2O^5 cost differential between low (some NPKs and SSP) - and high DAP, MAP and TSP) - analysis phosphate fertilizers will decline with the application of the incremental cost of environmental compliance on the high-analysis phosphoric acid-based products. This will increase the break-even distribution distance for the lower analysis products. Many developing countries still adhere to pan-territorial (uniform) delivered pricing policies for fertilizers regardless of distance from supply. This distorts the real farm-gate cost and inhibits the marketing of low-analysis products in markets located close to the source of supply. The natural market areas for low-analysis products such as SSP and some NPKs will be increased if pricing policies reflect the true cost of distribution.

Restrictive Fertilizer Product Legislation

Legislation designed to encourage or protect local or regional production and marketing initiatives can result in product mixes that may actually be detrimental to meeting the agronomic needs of the crop in addition to having an adverse impact on the environment at the level of production and use. To encourage, where economically appropriate, changes in product mix towards less soluble phosphate forms (less dependency upon phosphoric acid), there is a need for fertilizer legislation in many countries to be amended so that all agronomically suitable sources of phosphate can be used by farmers without penalty. Many developing countries providing production or end-user subsidies for phosphate fertilizers restrict eligibility for such subsidies by specifying the product type, nutrient source, and water-soluble P_2O_5 content. Unless such restrictions are removed, the use of less water-soluble products, even though they may be agronomically effective and less costly, will be constrained.

Difficulty in Changing Farmers' Practices

When considering a change from one fertilizer product type or use practice to another, it is most important to evaluate the results of such change in the context of farm-level benefit/cost criteria under actual farming conditions. Because

reliable benefit/cost data are often lacking, it is difficult to develop a convincing case for using any type of fertilizer let alone changing or tailoring the product type to reflect a more environmentally optimum mix of products.

An environmentally sustainable phosphate industry can only be achieved at an additional cost. This cost will undoubtedly be initially borne by the farmer, but it will ultimately be transferred to the consumer of agricultural products if fertilizer use and crop production are to be maintained or increased. In developed economies this does not pose a major problem; however, in the developing countries, characterized by resource-poor farmers and large and poor urban populations, considerable problems arise. In those developing countries where farm prices have been kept below international parity prices, there is a need to progressively increase farm prices to parity in order to provide sufficient incentives for farmers to ensure and promote the use of the more costly, but environmentally sustainable, fertilizers. Unless developing countries with low-cost food policies increase crop prices to maintain farmer benefits, food crop production will decline, adding to the problem of food security.

Partial resolution for the problem of increased phosphate fertilizer costs at the farm level lies in improving phosphate fertilizer use efficiency. It is therefore essential that a high priority be given to programs that will assist developing countries in improving use efficiency of phosphate fertilizers through improved application methods and the use of integrated nutrient management systems.

Plastics Recycling in Shanghai

The Xing Guang plastics factory in Shanghai recycles 2,000 tons of plastics waste every year - PVC, PMMA, nylon and plastics film from agriculture.

The plant was established with UNIDO assistance for the Shanghai Resource Recovery and Utilization Company, funded from the Belgian Government and with technology from Fabrique Nationale Herstel S.A. in Belgium.

Plastics are very durable and therefore useful. For the same reason, they pose serious environmental problems. Originally the plant was intended to address urban waste problems, particularly polluted PVC pipes. New technology is now being installed to recycle black polyethylene foil. In China, agricultural fields are covered with such foil during the growing season in order to trap the sunshine heat.

Plastics and Plastics Waste Recycling

Case Study No. 5

Executive Summary

EXPLANATORY NOTES

ABS	acrylonitrile butadiene styrene
APP	atactic polypropylene
HDPE	high density polyethylene
LDPE	low density polyethylene
LLDPE	linear low density polyethylene
PET	polyethylene terephthalate
PP	polypropylene
PS	polystyrene
PVC	polyvinylchloride
SAN	styrene acrylonitrile

In August 1991, $US 1 - DM 1.75

INTRODUCTION - THE PLASTICS INDUSTRY

The development of synthetic plastic materials undoubtedly has been one of the major technical achievements of the twentieth century.

The production of plastics has enjoyed a tremendous growth in industrialized countries, mainly because plastics are light, easy to process and convenient to use. Their consumption is still expanding (albeit at a more reasonable growth rate)and becoming an environmental problem.

Bulk plastics are generally produced by large international or local state-held companies which have their main activity in oil refining and/or petrochemicals. Companies of this size are highly structured with separate administrative, financial, marketing and R & D divisions and production facilities. The typical capacity of production for bulk plastics is in the range of 40,000 to 400,000 t/a per production plant. Engineering plastics are manufactured in plants whose size is typically one order of magnitude smaller. Industrialized countries have much higher per capita production and consumption figures than others.

Plastics can be converted according to different techniques. The most important are injection and blow moulding, extrusion and thermoforming. In most developing countries there is little conversion capacity available, so that many plastic products are imported, either as a part of various kinds of equipment or as packaging. Local production is generally less diversified from the viewpoint of both the plastics and the conversion methods used.

Some conversion methods, such as extrusion and calendering, are mainly directed to the production of semi-finished goods (sheets, plates, profiles, tubes, etc.), others are mainly used for producing machine parts (injection) or packaging (blow moulding, thermoforming, injection). The unit investment required is highly variable depending on the following factors:

- type of processing;
- size and capacity of the unit;
- new or second-hand equipment;
- level of automation;
- presence of peripheric equipment (automatic feeding of granulate, collection, grouping and packaging of products).

The conversion of plastics requires a sizeable amount of electric power. The availability of adequate amounts of cooling water is also an important factor in selecting a site for the production facilities.

The production of plastics is accompanied by the formation of some by-products, such as low molecular weight polymer, atactic polypropylene, reactor crusts, wastewater polymer sludge. Most production waste can readily be recycled.

The per capita consumption of plastics in developing countries is much lower than elsewhere and mainly directed towards products of first necessity. However, both the local production and the available inventory can be expected to grow considerably in the future. In the context of sustained growth, attention should be given to:

- proper use of the raw materials and energy;
- stimulation of reuse, recycling and, as a last resort, waste as a source of fuel;
- environmental aspects, including the proper management of production residues and post consumer plastics waste.

Recycling options

It would seem that all thermoplastics materials are predestinated to be recycled as they are valuable and can be remoulded innumerable times. However, little progress has been achieved in recycling consumer waste in industrialized countries.

Plastics reclamation and recycling can be subdivided into the following steps:

- source separation of plastics waste possibly supplemented by curbside and dumpsite retrieval;
- identification, grouping and sorting;
- shredding, washing, drying;
- regranulation, possibly after preliminary densification;
- conversion to new products.

The most critical steps in the process are:

- a correct identification of the plastics in hand. Mixing different resins leads to a catastrophic loss in quality and to the manufacturing of useless products;
- regranulation of contaminated materials requires experience and good strainers. Light materials have to be fed by means of a special auger feeder.

Plastics waste generated by polymer manufacturers consists of:

- production waste, such as the deposits formed on the walls of a polymerization vessel or the driers, or sludges separated from process waters;
- off grade products;
- extrusion purgings and lumps;
- floor sweepings;
- waste arising during quality control and laboratory testing.

Manufacturers are large multinational petrochemical companies, which normally will not commercialize off-grade products under their own trade names, or indulge in relatively small-scale reclamation. Their waste is taken over by specialized recycling firms which classify it according to homogeneity and condition.

Off-grade products are directed towards non-critical applications. Floor sweepings are carefully purified by means of mechanized sorting methods, which should completely eliminate dust, dirt and occasional foreign objects. Sweepings are composed of various grades of the same polymer; which cannot be separated by simple means. Suitable outlets should be found, which take into account the unusual rheological properties of such a mixture.

Atactic polypropylene (APP), which for a long time has been a useless by-product of propylene polymerization, is no longer a problem:

- improvements in the catalyst system, the reactor configuration and operating conditions have considerably reduced the generation of APP;
- all available APP is recovered and blended into roofing or road asphalt bitumen to improve its elasticity and mechanical properties.

Low molecular weight polyethylene polymer can also be reused to a certain extent.

Technical improvements in both equipment and polymer quality have considerably reduced the occurrence of production losses. Sprues from injection moulding have been eliminated by the use of hot runners. A better mould design, suitable injection cycle and polymer quality control reduce the occurrence of incompletely formed objects. Also the ejection and the collection of the products has been markedly improved, so that less injected parts are inadvertently caught by the closing of the mould.

Even smaller firms can no longer afford to waste these raw materials. Waste is carefully segregated at the source, according to its nature, colour, and additives. Contamination by dust, oil or burned (i.e. thermally decomposed) material is avoided. In general the waste is ground and recycled, either directly in the same or a similar production, or in a less critical application.

The most important potential source of plastics waste is to be found in consumer waste, arising in trade and industry and in private households. Municipal refuse in industrialized countries typically contains about 7 wt.% of plastics.

Consumer waste forms a largely untapped source of recyclable plastics. Some well defined industrial waste has been recycled after use, e.g. plastic containers, fertilizer bags, agricultural film, shrinking film, shockproof packaging, etc. Outside developing countries plastics present in municipal refuse have never been recycled on a long-term consistent commercial basis.

A major difficulty lies in the logistic problem of collecting suitable amounts of plastics, which are reasonably free from putrescibles and contaminants and can be transported economically to the cleaning, grading and reprocessing plant.

BARRIERS

Technical barriers

Plastics waste is available in a wide variety of types, forms, kinds and levels of contamination. A substantial range of recycling technologies are required. Some are mature, others developmental.

Currently, no mechanical system is proven or available to separate plastics waste into its different constituents and meet the requirements of the recycling industry.

Economic barriers

The largest tonnage of plastics waste available for recycling is post consumer consisting of mixed and/or contaminated products.

The collection of plastic materials may assume different forms, such as:

- door to door collection of source separated plastics;
- separate collection by civic associations;
- collection at schools;
- manual sorting of household waste at a sorting belt;
- source separated waste delivered by an individual to a container park, civic centre shop, etc.

Dumpsite collection is unsanitary and dangerous to public health.

Processing costs for plastics waste can be subdivided into:

- Manual sorting or cleaning costs. These are inversely proportional to productivity, which in turn is related to the type of operation, e.g.:

  * picking plastic bottles from a refuse stream;
  * splitting a plastics stream into a number of categories;
  * skimming a plastics stream for recognizable objects;
  * manually clean plastic products by eliminating PVC from polyolefin film, removing caps from bottles, etc.

(The productivity of such operations is very poorly documented).

In developing countries the investment cost of recycling equipment including mill, additive blending and regranulation may be prohibitive. On the other hand labour for collection is usually available and cheap. The manual washing of contaminated agricultural film poses no problem provided that suitable feeding or sintering equipment is available.

Social issues

Plastics waste is being actively recycled in most developing countries. Collection takes place at several levels:

(1) Waste may be collected at source (in homes or in shops, etc.). This system is only feasible when there is a well organized collection circuit so that everyone can supply the material.
Some major cities have an organized network of shops buying source-segregated waste materials;

(2) More frequently, recyclable waste materials are scavenged from household dust bins. Recyclable materials can be set aside by the rubbish collection crews and marketed on their way to the disposal site. The latter system operates for plastics materials. Finally, the scavenging of recyclable waste materials at the tipping site is an essential activity for a number of trades that depend on this supply. However, the conditions can vary, depending on the degree of organization.

Many of the people active in the recycling circuit are regarded as unskilled labourers operating under harsh conditions both financially and in terms of the working environment.

Scavenging on the dumpsite may be officially forbidden but frequently is tolerated. Under these conditions the scavengers enjoy no protection and even operate immediately in the tracks of compacting equipment. Organization of this activity is well established with individuals financing the operation and allocating territory and fixing pay scales.

A more just regular organization of scavenging, sorting and cleaning would be more beneficial to all parties concerned. This could assume the form of sorting from a belt in a partly mechanized plant.

It is difficult to assess collection cost, because it may either be on a voluntary basis, with the selling of the material as a reward, or on a basis of cheap labour. Sorting normally is entirely manual. Washing often also proceeds by hand with the drying of shredded plastics by solar heat.

INITIATIVES

Government incentives to promote plastics recycling

For a number of years individual European Economic Community (EEC) countries as well as the EEC as an entity have taken measures to reduce the generation of refuse.

Current legislation in several EEC countries provides for banning non-recyclable or even non-reusable packaging and the compulsory recycling of (plastics) packaging.

Government incentives such as deposit schemes are required to promote recycling PET bottles and HDPE containers.

The requirements of some European countries can be summarized as follows[1]:

- Italy: 40 per cent of packaging to be recycled by 1992, with 50/50 material/energy.
  All shopping bags must be biodegradable or pay 100 lire/bag, tax.

- Holland: Different targets for packaging and the rest but the overall trend is for a 10 per cent reduction in waste, 50 per cent minimum re-use/recycling, 30 per cent incineration with energy recovery and 10 per cent maximum to landfill by year 2000, with intermediate 1994 targets.

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[1] The complete text is given in a recent publication entitled "The Plastics Waste Issue - A European View", Shell International Chemical Company Limited (M.T. Dennison), based on a speech delivered to the Dewitt Petrochemical Review, Houston, Texas, March 1991.

. Belgium: 30 per cent recycling by 1995; balance for incineration, with landfill last resort.

. UK: 50 per cent of recyclable to be recycled by year 2000; i.e. 25 per cent of total.

. France: 50 per cent ultimate recycling target, either as material or energy.

Recent packaging proposals for Germany are extremely demanding where a 64 per cent recycle rate is required by 1995, with energy recycling essentially excluded. There are also mandatory take-back requirements throughout the supply chain which can only be replaced by industry establishing separate waste collection and recovery outside the normal municipal system. This is called the "Dual System", which will be financed by a "Green Spot" approval system, where verification and approval of a package's recyclability will have to be obtained, with payment of some 0.02DM per package, depending on size, to cover the cost of collection and crude separation. A further fee to support a recycling subsidy is also being considered. The necessary industry structures required to operate the Dual System are currently being established, and no doubt other European countries will be following progress closely.

In contrast, initial proposals from the EEC were more flexible, seeking a recuperation rate of 80 per cent for packaging, but including energy recovery.

It is the role of both government and industry to provide a reliable source of information with respect to the hazards, as well as the economic potential related to plastics, including their production life cycle and waste aspects. The relative importance of the latter is particularly evident in non-industrialized countries because:

- the cost for collection, manual cleaning and sorting is more easily borne;
- the limited variety of plastic types eases their retrieval, identification and reclamation.

Industry initiatives

Major plastics users, including the automotive and appliance industries, are starting to view the use of plastics in their products from the standpoint of design for disassembly, where part-structure and composition take ease of separation and reuse into account. This would favour thermoplastics over thermosets and composites.

Opportunities exist for upgrading recycling technology. In Europe the major product is LDPE film retrieved from commercial packaging waste. The recycling operation has been mechanized by means of a suction duct. The washing of agricultural film is a well established operation. Some problems are the large amount of earth and abrasive sand, the exposure to ultraviolet light and the accidental presence of PVC film, which renders the reclaim unusable.

Priority R & D areas include development of coextrusion techniques, processing of plastic materials recovered from other recycling operations such as shredded cars and electronic components.

Plastics waste is usually recycled by specialized firms, which either upgrade the material and bring it up to specifications, or convert it to non-critical products, such as:

- garden hoses, drainage pipes, buckets, refuse bags, or toys in polyethylene (LDPE);
- plastic 'lumber'
- flooring, shoe soles, bicycle saddles, drainage pipes, protective cover plates in polyvinylchloride (PVC);
- foam products in polystyrene (PS);
- carpet underlayers in insulating packaging in polyamides (PA).

For a number of years in the USA PET bottles have been turned into fibre batting for pillows and comforters.

Several systems, based on sink/float principles or on hydrocyclone cascades, are being demonstrated and hold the promise of separating at least an olefinic fraction. Several recycling ventures are working on X-ray detectors which could then be connected to automated sorting systems to separate polyvinylchloride (PVC).

In developing countries factory techniques may be employed cleaning impact-proof polystyrene yoghurt beakers by means of shredding, washing in a conventional (laundry) washing machine, dewatering and thermal drying with hot air, generated by mixing flue gas and air.

Regranulation is often conducted using second-hand or even locally made equipment. An essential part is the strainer, taking out non-melting impurities, and degassing, to evacuate volatiles and residual moisture.

A better life for all in Pleven

The aluminium casting plant in Pleven is being extensively upgraded to reduce the serious environmental pollution at the plant and in the community.

UNIDO developed the comprehensive plant rehabilitation programme now under implementation by the Bulgarian authorities. Funding is being sought for further improvements.

The Pleven aluminium casting plant generates foreign currency and employment - as well as occupational hazards and environmental pollution. The initial UNIDO study indicated that the aluminium production, as it was, did not return a net profit to the community when all the financial, occupational and environmental cost factors were accounted for. The changes already implemented - new management, noise walls, better ventilation and electric trucks instead of diesel ones - total a domestic investment of $1.5 million. Another $3.5 million is needed to complete the programme.

Utilization of Brown Mud in Shandong

In Shandong in the People's Republic of China, the traditional local brickmaking factories are able to use a mixture of brown mud from the Shandong alumina plant and fly ash from the neighbouring coal-fired power station to make bricks and tiles.

UNIDO has undertaken a number of techno-economic studies on industrial use of red mud waste. These studies have been used to develop the technology used in China and for similar projects in India and Jamaica.

The raw material for production of aluminium is bauxite. When bauxite is refined, it yields alumina, which in turn is smelted into aluminium. The red or brown mud is a waste product from alumina production and constitutes a considerable environmental problem because there is so much of it - 30-40 million tonnes per year worldwide. Unless disposed of properly, it can contaminate the ground water and spread red dust over wide areas. Even when correctly managed, the unaesthetic effect and the mere space requirement of the vast mud ponds motivate the continued search for economic uses.

Other possible uses of red and brown mud include road construction and ceramics, cement, rubber and paint production. However, each of those sectors demand only fairly small quantities and the economies are uncertain. One promising new field is agriculture, where red mud can be used as a soil additive or substitute for certain crops.