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Transfer of environmentally sound technology, cooperation and capacity-building

Report of the Secretary-General

SUMMARY

The present report provides a point of departure for the discussions of the Inter-sessional Working Group established by the Commission on Sustainable Development at its first session. It draws primarily on contributions from two meetings held prior to the convening of the Working Group. Section I provides a list of proposals that have emerged from the preparatory meetings and from other sources. The experts may wish to consider these or other proposals that may arise from their discussions and suggest ways and means of implementing them. Section II deals with the generic factors affecting technology transfer. Section III provides a sectoral focus on the topics selected for discussion at the forthcoming session of the Commission on Sustainable Development.

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INTRODUCTION

1. The present report is provided as a point of departure for the deliberations of the Inter-sessional Ad Hoc Open-ended Working Group on Technology Transfer and Cooperation. The purpose of the report is to suggest certain topics that may require additional discussion and to highlight some key proposals that the Working Group may wish to consider in order to promote international cooperation in the transfer of environmentally sound technologies.

2. The material presented draws primarily on contributions made by two meetings on technology transfer held prior to the convening of the Working Group. The first was sponsored by the Government of Norway and the United Nations Conference on Trade and Development and was held at Oslo from 13 to 15 October 1993. The second was sponsored by the Governments of Colombia and the United States of America and held at Cartagena, Colombia from 17 to 19 November 1993. Since the results of these meetings have been considerably condensed and synthesized for the purposes of the present report, the full reports of the two meetings are available for reference. In addition, contributions received from organizations of the United Nations system which specialize in the sectoral topics discussed herein have been incorporated. Useful advice, suggestions and contributions received from individual experts and non-governmental and other organizations have also been reflected to the extent possible.

3. Section I below provides a list of proposals that have emerged from the preparatory meetings and from other sources. The experts may wish to consider these or other proposals that may arise from their discussions and suggest ways and means of implementing them. Section II covers some of the generic factors affecting technology transfer, while section III provides a sectoral focus on the topics selected for discussion at the forthcoming session of the Commission on Sustainable Development.

I. SUMMARY OF PROPOSALS WHICH THE WORKING GROUP MAY WISH TO CONSIDER TO FACILITATE THE TRANSFER OF ENVIRONMENTALLY SOUND TECHNOLOGIES

4. The following is a list of key proposals that emerged during the preparatory process for the Working Group or that are referred to in other sections of the present report. The Working Group may wish to consider these proposals and suggest possible means of implementing them.

A. Proposals on ways and means of increasing access to information on environmentally sound technologies, including state-of-the-art technologies and those in the public domain

5. Comprehensive studies on the information systems that already exist and the extent and pattern of usage of these systems may need to be undertaken as a first step to understanding the nature of the information access problem.

6. An international network of clearing-houses for technology information and information referral could be established. An inventory of existing clearing-houses might be developed to help define the international network. Utilizing publications along with CD-ROM, Internet and other electronic media, regional clearing-houses could provide information on environmental sound technologies.

7. The concept of clearing-houses could also be expanded to private sector initiatives through the establishment of "independent technology transfer agencies" (ITTAs). ITTAs could serve as links between technology originators and technology recipients and encourage a greater commitment from the private sector to the transfer of environmentally sound technologies.

8. It might be useful to consider the creation of "one-stop shops" within developing countries which could assist potential investors obtain all required information on investment conditions from one source. These "shops" would centralize the information available within the country on all aspects of national conditions related to the transfer of technology. They would act as referral centres to provide information and other services (e.g., consulting services) relevant to technology transfer.

9. A study could be conducted of the issues and options concerning access to and the transfer of information on technologies in the public domain. An inventory of technologies for different sectors in the public domain could be undertaken and information on these technologies made available through the information network. A specific agency should be designated to carry out this work.

10. Demonstration projects are needed to show the effectiveness and appropriateness of technologies to specific country applications. Demonstrations can be designed to display an individual technique or technology or disseminate systems where know-how is shared first, so that users can make an educated decision on the type of equipment to purchase.

11. Reports and case studies could be disseminated about successful applications of environmentally sound technologies. The case study should describe the application conditions so that potential users can assess appropriateness for their needs. Summary statistics about technical effectiveness, costs, return on investment, efficiency, operation and maintenance requirements could also be prepared. Names and organizational contacts could be provided for additional information on the case study.

12. Public information programmes including audio/visual displays could be developed. Support for non-governmental public education programmes on urban and industrial pollution problems and environmentally sound technologies could be provided.

13. Industry programmes involving local communities could be established to improve industry-community relations. These programmes would include industrial disclosure of chemical usage, environmental releases, emergency response plans and responsible care.

B. Proposals for collaborative arrangements and partnerships to remove commercial and non-commercial barriers to technology transfer, use and dissemination

14. A study could be conducted, analysing the issues and options dealing with compulsory licensing, intellectual property rights, patent rights and related issues of environmentally sound technology, and recommendations could be made for improving access to and transfer of these technologies to developing countries.

15. Benchmarking is an effective instrument for assessing, monitoring and encouraging best practice standards at the firm level. A collaborative effort between appropriate international bodies and private sector firms to find acceptable means of extending its effectiveness should be established.

16. Not all proprietary knowledge is in private hands and means of accelerating the transfer of public knowledge could improve access to environmentally sound technologies. An international agency could be designated to act as an effective information gathering and networking agency.

17. Governments could be encouraged to establish centralized, national referral services for information on publicly-owned technology. Non-governmental groups and non-profit organizations may also be encouraged to participate in national referral services for information on publicly owned technologies.

C. Proposals for incentives to stimulate the transfer, use and dissemination of environmentally sound technologies

18. Efforts in the area of technological cooperation need to encourage continual upgrading of environmental standards. Funds need to be mobilized and made available to provide incentives for helping the private sector to undertake technological initiatives in countries and sectors where market incentives would not induce such behaviour.

19. The absence or weakness of effective regulatory structures and enforcement mechanisms presents a major obstacle to the attraction of environmentally sound technologies. Priority may be given to starting the process by designing minimally effective, simple regulatory systems and then on the gradual development of more effective measures over time.

20. Industrial estates and clusters of industries (especially small and medium-sized industry) where environmental capital costs and operations and maintenance expenses are shared could be promoted.

D. Proposals to address capacity-building needs for the effective use and dissemination of environmentally sound technologies

21. Environmental audit procedures and manuals, programmes for self-assessment of compliance and electronic systems for specific industries could be developed.

22. Teaming could be promoted between national and foreign experts, between national organizations and foreign corporations, including transnational corporations, and between foreign and national municipalities to exchange know-how and technology.

23. An experts exchange programme could be established to identify and provide funding for exchanges among developing country technology experts who now reside in industrialized countries but wish to use their knowledge to help their country of origin.

24. Study tours could be conducted so that foreign specialists may visit industrialized countries to acquire hands-on skills and expertise with relevant technologies.

25. Manuals on environmentally sound technologies could be prepared, implementation procedures established and in-country training, workshops and technology fairs conducted.

26. A network of research centres focusing on environmentally sound technologies could be established.

E. Proposals for financial arrangements and partnerships to promote the transfer, use and dissemination of environmentally sound technologies

27. A detailed assessment of the current level of funding for technology transfer assistance to developing countries from bilateral, multilateral and other sources could be conducted. Funding should be broken down by country, sector, funding source, type of programme and other relevant factors.

28. Efforts to encourage private investment, such as reducing trade barriers, encouraging competition, opening up markets to foreign collaboration, reducing corporate taxes, allowing exchange rates to float and other market reforms and sector restructuring are likely to have a substantial impact on improving access to capital for new technologies.

29. An "environmentally sound technology rights bank" (ESTRB) could be created as an intermediary that would acquire patent rights to sounder technologies and make them available to developing countries under favourable terms. Such a bank would cover as much of the developing world as possible; the technology owner would retain exploitative rights in the industrialized regions.

30. A financing facility could be created for joint venture technology development and commercialization involving enterprises from developed and

developing countries. The main concern of developed country firms is the level of risk associated with product development and commercialization, particularly when investing in developing countries.

31. Lending policies based on loans where funds paid back are used to make new loans could be promoted. It would be necessary to improve the understanding of industry and consulting companies about the requirements of lending institutions for technical and economic feasibility analyses that support loans.

II. FACTORS AFFECTING TECHNOLOGY TRANSFER, COOPERATION AND CAPACITY-BUILDING

A. Environmentally sound technologies

32. The Oslo Workshop on the Transfer and Development of Environmentally Sound Technologies noted that environmental "soundness" is not an absolute concept and that the performance and environmental impacts of technological systems depend strongly on how the technology is applied in the local context. Technologies transferred from one country to another cannot always be expected to perform in the same way. The impact on local ecological resources and populations may be very different. A more operational typology is needed to help unravel the bundle of issues involved in the transfer process. Among the unresolved issues at Oslo was whether end-of-pipe and other remedial technologies or only preventive technologies of a more systemic nature, such as cleaner and efficient processes of production should be covered by the term "environmentally sound technologies". 1/

33. The definition of technology should go beyond equipment and hardware to include services, information and techniques. This "non-hardware" or "software" area of technology is an integral part of the technology transfer equation. Policy, regulatory, legal, institutional or financial/economic incentives or approaches and new market-based techniques that permit efficient delivery of technology services may also form part of the technology transfer package. 2/

34. Significant changes in the global economic and political environment, a shift of focus from the generation of technology to the dissemination of existing technologies and current best practices, and to the question of absorption at the local level, have to be fully incorporated into the discussion of environmentally sound technologies. These changes coincide with the growing awareness of a greater role for market coordination in the development process and the evolving nature of governmental intervention.

B. Access to and dissemination of information about technology

35. Information constraints are seen as a real and potential threat to technology transfer which can be partly overcome through more collaborative initiatives between Governments and the private sector. Brokering institutions such as technology centres and information exchange mechanisms can also help. A switchboard function, which could direct users to who has what information, is more likely to be effective than attempts to create centralized databases. A

better international network to maximize the effective use of existing resources is also important. 1/

36. A Joint International Development Research Centre (IDRC)/Earth Council Workshop noted, however, that a number of information systems, databases and networks already exist. Although thorough and reliable studies are lacking, evidence suggests that a key constraint for developing countries is not the lack of information or information systems, but rather a shortage of mechanisms and incentives to promote the dissemination of this information to individual users, particularly small firms. 3/

37. None the less, the need for information is consistently identified as a major bottleneck in the transfer of technology. It would appear, therefore, that three different actions are called for in order to address this problem:

(a) Comprehensive studies on what information systems already exist, the extent and pattern of usage of these systems, and obstacles to entry (e.g., cost, hardware and software, training);

(b) The studies should also identify what, if any, important information is missing. For example, do the data include information about financing requirements and/or availability? About relevant policies, such as tax incentives and export credits? About opportunities for cooperation with small and medium-sized companies? Is this information not available because of cost, proprietary rights, problems of organization, oversight?

(c) Information systems tend to have a specialized clientele, located within single ministries or departments. Potential users may not even be aware of the existence of the information available in or accessible through their government offices. It might be useful to consider the creation of "one-stop shops" within developing countries which could assist potential investors obtain all required information on investment conditions from one source. These "shops" would centralize the information available within the country on all aspects of national conditions related to the transfer of technology. They would act as referral centres to provide information and other services (e.g., consulting services) relevant to technology transfer.

38. Special programmes for better patent-related information may also be considered (see sect. D.2 below on intellectual property rights).

C. Role of the private and public sectors 4/

39. The role of government is to provide effective incentives and a supportive infrastructure, particularly in developing countries, where the commercialization of environmentally sound technologies is likely to face the greatest obstacles. Where technologies are owned by small and medium-sized enterprises, these problems are compounded. Export promotion schemes are considered to be one possible avenue to pursue in this context. However, purely commercial transactions are not likely to induce a full environmental improvement. In addition, technology-exporting countries should closely examine the terms and conditions under which technology transfer takes place to

determine possible steps to improve the concessional and preferential dimension of such transfers.

40. Open markets, a stable and predictable economic environment, including predictable environmental regulations, constitute enabling conditions for fruitful technology cooperation and long-term involvement. Full cost pricing, tax reforms and the removal of subsidies, especially in the areas of natural resources and energy, are also likely to stimulate environmental responsiveness by the private sector in both the North and the South. 2/

41. National efforts are not sufficient; they must be extended upwards to the bilateral and multilateral levels and also downwards to the local level. But more important, horizontal bridges must be built and strengthened to support technological capacities and environmental awareness (e.g., between firms, between research institutes, between donors of official development assistance (ODA) and between non-governmental organizations). South-South cooperation remains underutilized and merits greater attention, particularly where environmental problems have a clear subregional and regional dimension.

42. Modernizing government structures provides an important starting point from which to enhance environmental performance. These reform measures extend to the important area of government research and development activities, where a refocus on improving the commercialization of environmental technologies is considered important. Partnerships with private sector firms would be essential.

43. Governments and international organizations should adopt a bottom-up approach to identifying specific local needs, infrastructural conditions and available capacities. Local industry, communities, non-governmental organizations and Governments should all participate in identifying environmental problems and considering solutions.

44. Government reforms would be essential at the local level, particularly as many environmental problems are increasingly coming under their jurisdiction. Capacity-building is urgently needed to strengthen enforcement and monitoring capacities in the realm of environmental management.

45. Firms have a positive role to play as the key agents of technology generation and transfer and in improving environmental conditions. This needs to be given wider exposure and additional encouragement.

46. Governments should work with industry in identifying current best practice and existing technologies that could contribute to solving specific environmental problems faced by economically disadvantaged countries.

47. Firms, in particular transnational corporations, can play an important role in promoting environmental awareness in countries where they operate. The involvement of transnational corporations in the economies of developing countries was seen as an opportunity to spread environmental awareness and higher environmental standards.

48. Better dialogues should be established between transnational corporations, Governments and local firms through new partnerships and other innovative institutional forums such as technology centres and centres of excellence for the dissemination of information and training.

D. Commercial factors

1. Foreign direct investment 5/

49. Technology transfer is often a component of foreign direct investment (FDI). Such transfers may occur among affiliates (parent firm and branches or subsidiaries) or through a joint venture. In either case, the attraction lies in the fact that the supplier retains control and earns dividends rather than royalties. A recipient may benefit from investment of foreign capital and long-term cooperation.

50. Foreign direct investments are directly tied to issues of national regulations and policies, as well as capacity. They are purely commercial transactions and are therefore undertaken only when the political, economic and technical climates are considered suitable and predictable for a long-term investment and profitability. Governments may seek to attract FDI for environmentally sound technologies through a number of policy instruments, such as tax holidays, grants, subsidizing a portion of pollution control expenses and assisting in waste disposal. Transparent regulations and policies, easily accessible information on national capacities and "one-stop shops" may facilitate the early contacts of prospective investors.

2. Intellectual property rights

51. The Oslo Workshop and other forums have noted the differences in access to privately held environmentally sound technologies. There are cases where the owners of technology are unwilling to make it available to licensees, or have set very high prices on it. At the other end of the scale, there are cases where environmentally sounder technologies are more or less freely available, but are not transferred to developing countries for lack of an attractive market opportunity. There are also cases where the costs of transfer are too high, and concessional financial support or innovative institutional arrangements are needed.

52. Some experts believe that access to environmentally sound technologies is more an issue of finance than of patents and licences. Small companies in developing countries that lack the financial resources of large corporations face the biggest constraints when acquiring proprietary rights. The purchasing or licensing of patents clearly carries a price. There are situations in which users may legally avoid paying a fee. For example, potential users may exploit technological information which is patented in some countries but not in their own. Some countries have compulsory licensing legislation. However, what is often not understood is that, while a patent may contain only information about equipment or a process, licensing or joint ventures generally contain three components: the intellectual property (technological information); the hardware

(e.g., plant and equipment); and, perhaps most important, technical assistance for operating, adapting and managing the technology.

53. There are three key issues concerned with intellectual property rights. The first is the question of information: how do companies or other purchasers of intellectual property know the range of technologies available for their purposes and their comparative advantages? The second is the question of access: are countries denied intellectual property for other than financial reasons? The third is the question of finance: from what source will foreign exchange be available for companies in developing countries?

54. Suggestions have been made for the public purchase of patents which could be made available on concessional terms to developing countries, to facilitate the dissemination of environmentally sound technologies. A recent initiative under the PHARE (Pologne-Hongrie: Assistance à la restructuration économique) programme of the Commission of the European Communities has attracted considerable interest along these lines. However, it would be important to keep in mind that such arrangements would need to transfer all three components of the technology - the intellectual property, the hardware and the technical support - and not the patent alone in order to be successful.

55. The main source of information about intellectual property is the national patent office, where the technical information, the name of the patent holder and other relevant information are publicly available. In addition, the World Intellectual Property Organization (WIPO) of the United Nations system acts as an international conduit of national patent information. Upon request, WIPO will provide state-of-art searches for specific technologies, or sub-classes of technologies. It will also, at cost, 6/ commission technology profiles. These profiles compile data on all new technologies (patents) in a given area (e.g., solar energy) and analyse the data with respect to a number of parameters relevant to technology transfer and application.

56. What does not now exist is a patent classification or description that marks a technology as "environmentally sound", or "cleaner". Obviously very specific, accepted technological criteria would be required for a technology to be described as "environmentally sound". If such criteria could be developed and adopted, then a patent application, in addition to proving novelty and industrial applicability, could also demonstrate environmental soundness. This would not have to be a requirement for patentability, but for flagging certain technologies which might be of special interest. An alternative method would be for a patent holder to have an opportunity, on a voluntary basis, to apply for a "listing" of her/his technology as environmentally sound. This would also require consensus on standardized criteria.

3. Publicly owned technologies and technologies in the public domain

57. The issue of publicly owned technologies and technologies in the public domain has come up in several different meetings and contexts.

58. Technologies may be in the public domain either because they have never been patented or because their patents have expired. The first category may include technologies of limited commercial value or technologies designed to correct very specific problems, which in turn are very sophisticated and not easily copied. Even when the technology (i.e., the technological information) is freely available and relevant, without the related hardware and technical assistance the value of the information would most likely be limited to countries with a highly developed technical capacity.

59. For technologies whose patents have expired, the situation may be different, since the technological information contained in the patent may be without a specific context. Patents expire from between 17 and 20 years. After that time, the technology enters the public domain. In addition, patents lapse if annual fees are not paid by the patent holder. It has been estimated that most patents are abandoned within five to seven years because the annual fees are not paid. In many cases such fees are progressive, and the cost of maintaining them ceases to be economic. Large companies in the private sector monitor the early expiration of patents, and the information is available through private services. The cost of subscribing to these services is, however, extremely high - from US$ 3,000 to US$ 7,000 per year per sub-category of technology. If a user can identify the precise patent of interest, then it is a simple, inexpensive and public matter to determine whether or not the patent has entered the public domain. To monitor the status of all technologies, or even whole sectors of technologies, however, would be beyond the scope of current available funding.

60. Technologies are also owned by the public sector, including both Governments and non-profit organizations. Information about government-owned technologies is usually only available on a Government-by-Government, ministry-by-ministry and, possibly, laboratory-by-laboratory basis. Although technology is owned by Governments, it is not necessarily freely available. On the contrary, some Governments employ officers just to promote the licensing of their publicly owned technologies. None the less, the technology may be less expensive than privately held patents and, more important, it may come partially packaged with financing for demonstration and adaptation.

E. Role of technology assessment

61. In various workshops which have been organized over the past two years, several issues with respect to technology assessment have become apparent. Primary among these has been the reluctance of both national decision makers and firms to rely on technology assessment. In both cases, technology assessment has been viewed as a limiting, or controlling, factor in decision-making. It has been perceived as holding both an adversarial and a normative position, one in which decisions are scrutinized and judged to be either good or bad. Technology assessment, however, should be viewed as a valuable input to the decision-making process. It is the decision makers themselves, whether they are government ministers, planning commissions or corporate executives, who set the parameters and establish the criteria for assessment. For example, some of these criteria may be identified by environmental regulations; others by market or social needs; still others by skill requirements; and so forth. Within these

parameters, technology assessment specialists gather and analyse the relevant information and present it for consideration. Decision makers still make the decisions.

62. Once this concept has been accepted, a number of other issues arise. One is organizational. Who does the assessment, how independent of the decision makers are they, and where are they located structurally? Although some general answers may be provided based on empirical evidence, the answers will be as individual to a country or a firm as are the final decisions themselves.

63. Another issue is methodological. A number of different methodologies for assessment are available. Some of these are more directly related to policy; others to projects; and still others to specific technologies. Some are concerned solely with environmental parameters; others with a whole range of social, economic, cultural and environmental factors. Again, decision makers should decide which methodologies are the most appropriate to their needs. In every case, however, it is essential that workshops and training courses be made available to teach these methodologies. In general, this is done best at the national level, working with real case examples of policies, projects or technologies which require assessment. Apart from national modalities, consideration might also be given to the international exchange of assessments, where this is feasible.

64. A third issue relates to information gathering. Although this is actually a subset of the methodological questions, it has its own requirements. One of the most important aspects of information gathering is participatory needs assessment. A growing number of countries and firms are relying on multi-stakeholder processes, or "round tables", as a means of involving diverse interest groups in the identification of environment and development problems and strategies. 3/ Information should also be received regularly from the national patent offices, as well as from other sources of information on new and "best-practice" technologies. This is especially relevant to the various patent-related services, such as the state-of-the-art searches.

F. Institutional capabilities and capacity-building

65. The Oslo Workshop stressed the need to build local capabilities for sustainable development as an integrated part of a broader agenda for sound economic growth and structural change. Effective measures in this area, it was suggested, should be grounded at the firm level, as well as through efforts of industrial associations, research and development centres, national non-governmental organizations and public sector officials among others.

66. The importance of skill formation and know-how accumulation as necessary conditions for successful transactions that promote technological capacities was also noted. Hardware supply contracts should include relevant and results-oriented skills development. Technology transfer, in fact, requires a complex set of capabilities, for it demands that the user be able to use the technology in the manner intended, integrate it with an industry, a utility

and/or available services, maintain and repair it and adapt it to local conditions.

67. At the other end of the spectrum, business requires an enabling framework of preconditions for investment and technology cooperation, including macroeconomic stability, basic infrastructure in education and institutional development ensuring property rights, legal systems overseeing contracts and taxes. 7/

68. Information constitutes another major aspect of capacity-building. Learning to collect and arrange data at the national level provides an opportunity for honing technical and organizational skills. Gaining access to external information through electronic databases, referral systems and so forth not only increases the users' knowledge but also empowers them by bringing them into international networks of information and discourse.

69. There is a need to improve the institutional capacities of host Governments and create regulatory frameworks in the environmental sphere. There is considerable room both for North-South cooperation in this area and for a more strategic approach from the international community. 1/

G. Financial issues and mechanisms

70. Given the stagnation of official financial flows and the apparent absence of "new and additional financial resources", new financial mechanisms and means have to be explored and encouraged in order to promote the transfer of environmentally sound technologies. Overseas development aid, although desirable, is not enough. Rather, a more entrepreneurial approach is required in searching for future projects with environmental and economic pay-offs.

1. Intermediate ownership arrangements for concessional and preferential transfer

71. One possible suggestion for consideration by Governments and intergovernmental bodies is the creation of an "environmentally sound technology rights bank" (ESTRB) as an intermediary that would acquire patent rights to sounder technologies and make them available to developing countries under favourable terms. Such a bank would cover as much of the developing world as possible, while the technology owner would retain exploitative rights in the industrialized regions.

72. An ESTRB could increase the access of developing countries to environmentally sounder technologies by (a) negotiating the acquisition of such patent rights with transnational corporations and other technology developers on a fair commercial value basis; (b) accepting patents as donations from both private and public sources; and (c) initiating licences, commercial development agreements, and "use" agreements with suitable "users" in the developing countries. A version of this idea was generated (and tested for feasibility in four developing countries) by the United Nations Development Programme (UNDP) in a pilot project on creating a Technology Rights Bank. 8/ As with any technology

transfer, the negotiated rights would have to include not only the intellectual property but also the hardware and technical assistance, as relevant.

2. Venture capital fund

73. Considerable interest was paid in Oslo to a blueprint proposal initiated within the World Bank to establish a venture capital fund for certain environmental technologies. This fund, called the Greenhouse Gas Mitigation Venture Capital Fund, is to be established with the International Finance Corporation on behalf of both government and private sector venture partners. The Fund would mobilize both public and private capital to leverage largely foreign private investment in projects which can effectively reduce greenhouse gas emissions consistent with national sustainable development plans and programmes in the energy, and possibly other, sectors, such as industry, agriculture and forestry. These investments are seen as win-win investments in that they would provide developed and developing country private enterprise partners with acceptable returns on investments and developing economies with the know-how associated with commercially demonstrated new technologies and the potential spin-offs for economic growth. 9/

3. Joint ventures

74. In many of the developing countries, current financing for technology development and commercialization is inadequate, with the result that several innovative technologies have not been developed, nor have the potential markets been field tested. Unfortunately, most multilateral development banks and international financing institutions are technologically risk-averse. 10/ A financing facility could be created for joint venture technology development and commercialization (including involving enterprises from developed and developing countries). The main concern of developed country firms is the level of risk associated with product development and commercialization, particularly when investing in developing countries. 11/

75. Such financing mechanisms can reduce the level of risk associated with new product development, and could provide incentives for bringing efficient technology into the market-place. It therefore follows that there is a strong case to be made for promoting cost-shared market-driven research in critical technology areas. The development and commercialization process could involve consortia that include manufacturers, universities and national laboratories to tap the private sector for innovative technology. A hallmark of this approach is that developing countries participate directly in the development and adaptation of innovative technologies, and thus are able to influence the outcome so that these technologies are also appropriate to the developing country situation.

4. Build-operate-transfer

76. BOT (build-operate-transfer) arrangements, particularly for the construction, operation and cost recovery of big municipal waste treatment plants, are a relatively new approach to technology transfer. In this model, a private company builds a project, operates it long enough to pay back its debt and to achieve a return on equity, and then transfers it to the host Government. Project finance is normally on a "limited recourse" basis - only income from the project will be used to repay lenders and investors. BOT revenues are derived either from user charges or from a pre-determined payment by the Government, regardless of the amount of usage. Variations include BOOT (build-own-operate-transfer); OCT (complete-operate-transfer); and BOOM (build-own-operate-manage). 12/ Emphasis should nevertheless be placed on promoting national efforts and national capacities in such undertakings.

III. TECHNOLOGY TRANSFER ISSUES BY SECTOR

A. Health

1. Main trends and critical factors

(a) Communicable diseases and their effective control 13/

77. In less than two decades, the HIV/AIDS pandemic has swept across all continents and regions of the world, and its impact has shattered families, sorely strained health systems and irrevocably altered the health of individuals and communities.

78. In promoting the transfer of technology to respond to the challenge presented by communicable diseases throughout the world, it would be significant to (a) promote the transfer of diagnostic and screening technologies; (b) develop the information systems to adapt and effectively use these technologies; (c) sustain the development of the technological infrastructure required for monitoring and control of communicable diseases; (d) strengthen national capacities to deal with the epidemic; and (e) increase public information and health education.

79. Acute respiratory infections (ARI) and diarrhoeal diseases (DD) are two of the most important causes of diseases and deaths in children under five years of age in developing countries. For both diseases, the most immediate and effective technologies for reducing mortality are those related to correct clinical management.

80. Essential antibiotics, oral rehydration (including oral rehydration salts) and feeding are readily available and have been adopted by practically all developing countries as the key technologies for the control of ARI and DD. They represent simple, effective, inexpensive and feasible technologies which can be used everywhere, even in the most inaccessible areas of developing countries, if the health workers are appropriately trained and supervised.

(b) Vaccination technology 14/

81. The introduction of new live vaccines in medical and veterinary practice, especially those developed with the use of genetically modified microorganisms, can in principle have adverse environmental impacts. In view of this, the accurate evaluation of all components of vaccine safety is a key subject for the transfer of vaccine technology to any country.

82. Main aspects of risk assessment should include the biological and reproductive properties of the microorganisms, the characteristics imparted by the genetic modification and the relevant attributes of the site where the vaccine is to be used. Risk assessment must be based on sound scientific principles, requiring participation of experts from appropriate disciplines.

83. Evaluation of risk should be conducted at each step of development from the research laboratory to small-scale and large-scale production and finally to commercial use. The evaluation system developed for new vaccines must be flexible and capable of being adapted in accordance with the latest scientific information.

84. Specific aspects for evaluating live vaccines are genetic stability, potential of shedding into the environment, interspecies transmission and ease of monitoring these events based on specific genetic markers.

85. Development of transgenic animals should be encouraged in cases where no animal models are available to provide the relevant information about the safety of a new product. This point could be illustrated by the establishment of transgenic mice for study of pathogenesis of infections caused by poliovirus and for assessment of new poliovirus candidate vaccines. However, the need for safety related to the release of transgenic mice to the wild should be identified.

86. Case-by-case evaluation should be the rule unless sufficient experience and an adequate body of knowledge is gathered to allow generalization based on experience and conclusions regarding the behaviour of vaccines.

2. Mechanisms and measures to improve the transfer of environmentally sound technologies

(a) Communicable diseases and their effective control

87. The development of technologies and techniques to monitor and assess the health situation in a country’s population in relation to the spread of infection with HIV is essential. It will help to analyse the stage that the epidemic has reached in a country and to develop response strategies.

88. To ensure that HIV-infected people and people with AIDS can be sustained, it is crucial to maintain the availability of essential drugs and other supplies required for their care. As many countries cannot afford the high cost related to the access and transfer of some of the technologies involved (e.g., patent

rights), further cooperation with the pharmaceutical industry is needed to enhance their availability.

89. The promotion and coordination of AIDS-related research on vaccines, drugs and diagnostic methods call for strengthening national research capabilities, for example through training activities, building of the laboratory infrastructure, including the transfer of appropriate technologies for virology, epidemiological research and data management, as well as clinical trials and social and behavioural studies.

90. The development and transfer of clinical management guidelines for the appropriate treatment of patients with opportunistic and related infections, such as tuberculosis, has become necessary. Equally important is the transfer of information on appropriate drugs and procedures in the treatment of sexually transmitted diseases.

91. The technology to produce oral rehydration salts (ORS) can be introduced and maintained in many developing countries, although in a few situations the high cost of the local ORS product may make it preferable to obtain it on the international market.

92. The ARI and DD control technologies are in the public domain. There are no secrets or patent restrictions for the production of high quality ORS and cotrimoxazole. Since its introduction, ORS has remained a product primarily available in the public health system and given to the patient free or at a low cost.

(b) Vaccination technology

93. As developing countries are the principal candidates for new vaccines, scientists from these countries should benefit from the tremendous progress industrialized countries are now experiencing in the different areas of immunology, biotechnology, vaccinology and biosafety, and become themselves involved in the development of new and improved vaccines. Transfer of environmentally sound technology for vaccine development throughout the world is an important objective.

94. To ensure the appropriate management of vaccination technology, countries need appropriate scientific and technical expertise, specific scientific advisory bodies, mechanisms to gather information on local environmental conditions, and systems for the provision of information to and education of the public.

95. The transfer of vaccination technology to countries calls for the establishment and maintenance of expert advisory panels, collection and dissemination of biotechnology information and a database of international and national regulations related to vaccination and biotechnology. International agencies should be encouraged to promote these activities.

96. Training of local scientists is a key subject in the transfer of environmentally sound technology to countries. The components of a training programme should include organization of short-term courses and extended periods

of training, during which selected participants can learn relevant techniques in detail; organization of a follow-up programme to provide continuous information and technical assistance to former participants in the above courses; organization of "refresher" regional courses aimed at continuing education by covering infectious diseases of priority to the area.

97. The final objective of a training programme is to create in many countries a nucleus of scientists that will play an institution-strengthening role and become directly involved in the development and evaluation of new vaccines.

98. In order to promote the transfer of vaccination technology to countries, a five-year fellowship programme associated with present research activities should be established. Local scientists should be trained in surveillance of stability of newly introduced genetically engineered viruses and bacteria (e.g., new live cholera vaccines), including possible recombination with wild organisms and reversal of attenuation.

B. Human settlements 15/

1. Main trends and critical factors

99. While the present section refers to energy in the context of programme E of chapter 7 of Agenda 21, 16/ transfer of technology issues in the energy sector could well include consideration of the exploration and development of conventional energy sources, such as coal, oil and natural gas, and the application of modern, cleaner technologies in order to reduce the adverse environmental effects of their development, transportation, transformation and use.

(a) Renewable energy systems in human settlements

Biomass energy

100. Perhaps the single largest application of renewable energy at the present time is the use of biomass for domestic cooking. Technologies for improving the efficiency of traditional cookstoves are accessible to most developing countries, but despite the efforts of aid agencies and non-governmental organizations, commercialization of energy-efficient cookstoves has met with limited success, mainly because of the lack of local entrepreneurial capacity, economic incentives and in some cases cultural barriers.

101. Biogasification is an extremely versatile and mature technology and has been adopted on a large scale in China and India. Yet the promise of the early 1970s has not materialized in most developing countries in the absence of aggressive dissemination backed by adequate extension services.

102. Some developing countries, notably Brazil and Zimbabwe, have demonstrated the commercial viability of liquid fuels derived from biomass (especially from the sugarcane industry) as full or partial replacement of petrol/gasoline for spark ignition engines. The technology is already available for commercial

transfer and many tropical countries have an excellent opportunity to upgrade their sugar industries to be co-producers of ethanol and electricity.

Solar energy

103. The main commercial technology in this field is solar water heaters incorporating flat-plate collectors. Small-scale solar stills suited for typical residential installation or for isolated rural communities are already available commercially in many developing countries, especially those with legislation or tax incentives to encourage their use. The technology is usually procured under licence from industrial countries or is developed indigenously. The technical feasibility of water pumping with solar thermodynamic, engine-driven pumps is well proved, but commercial viability of the technology is still hampered by high costs.

104. Photovoltaics (PV) have tremendous potential for applications in both urban and rural settlements. Advances achieved in solar cells and energy storage devices during the past decade have improved the commercial viability of PV power, especially for stand-alone uses in remote locations. While most cell production and PV modules still come from a handful of multinational groups, the immediate scope for technology transfer and local manufacturing lies in PV subsystems; commercial technology transfer is already happening on a limited scale.

Wind energy

105. Wind-energy technology is quite mature and has found applications in developing countries as both irrigation pumps and electricity generators. Attempts at transferring the technology of low-cost irrigation wind-pumps from one location to another have had limited success, mainly because of mismatches between wind-regimes, irrigation requirements and pump capacities. Nevertheless, efforts are currently under way in the Netherlands and the United Kingdom of Great Britain and Northern Ireland to develop wind pump technologies customized for transfer to developing countries with the support of external aid programmes.

106. Wind-generated electricity is currently cost-competitive with diesel generation only in specialized and remote applications. The technology for stand-alone systems is already commercialized in China and Mongolia, while current projects for the transfer of Danish grid-connected wind turbine technology are in progress in China, Egypt and India. The technology is well-suited to phased indigenization in countries having a medium-scale manufacturing industry.

Biomethanization

107. Methane is the most abundant atmospheric hydrocarbon released as a result of anaerobic degradation of biological systems. With a high global warming potential, global emission of methane is estimated to contribute substantially to the greenhouse effect. Therefore, recovery and gainful utilization of methane would offer the dual benefit of a reduction in greenhouse gases and a cleaner source of energy.

108. Biomethanization projects are being initiated in some developing countries, for example India and the United Republic of Tanzania. The objectives are (a) to generate energy/electricity and improve the quality of the environment; (b) to develop commercially viable technology packages ready for replication; and (c) to promote and disseminate the idea of generation and utilization of biogas, through high-rate biomethanization processes using various substrates.

Small-scale hydropower

109. Mini-hydro and micro-hydro technology is already established in several developing countries, most notably in China and Nepal, and its viability has been demonstrated by studies elsewhere, for example in Peru and the United Republic of Tanzania. Recent developments, especially in electronic controls for small systems and innovative turbine design for low-head hydropower, have reduced cost and improved efficiency and reliability, presenting new opportunities for technology transfer.

(b) Energy efficiency

110. A serious obstacle to improving energy efficiency lies in the institutional structure for energy decision-making. Access to information and access to capital are generally not concentrated in the hands of energy users, but in the supply side of the energy equation. Utilities make investment decisions, builders determine the appropriate level of building insulation, appliance manufacturers determine the energy efficiency of their products, but none of them pays the energy bill. Energy and product markets also fail to capture externalities.

111. Domestic capacity-building for the transfer and dissemination of renewable energy technologies and energy-efficient technologies in human settlements is a long-term programme. Human resource development efforts should specifically target national energy planning bodies, energy utilities, local entrepreneurs and non-governmental organizations active in the energy field. Experience has shown that a participatory approach with end-user involvement is crucial to successful formulation, implementation and follow-up of projects and programmes.

Energy efficiency in buildings

112. The principal means of improving energy efficiency in buildings are (a) energy-efficient design of buildings; (b) the use of improved insulation and control devices; and (c) other innovative measures, such as waste heat recovery from extracted air and waste water.

113. Two distinct categories of technology transfer can be considered in this context. The first is of intellectual goods, including environmental modelling techniques and computer software. Many of these techniques and softwares have been developed by universities and research institutions and are in the public domain. However, expert interpretation is often required for their use. Commercial software is also available internationally; it can be procured through licensing arrangements, taking into account intellectual property rights.

114. The second category of technology transfer relates to physical products and processes. Examples include building fabric insulation products and advanced glazing technology, as well as lighting and heating control systems and active solar systems. Since many of these products and processes are recently developed, improved access to product and process-related information, as well as to listings of suppliers and consultants, would help to speed up the transfer of these technologies.

Lighting and refrigeration systems 2/

115. Lighting is the single largest user of electricity in commercial offices and residential buildings in developed countries and accounts for, typically, 10 to 15 per cent of total electricity use in a developing country. Incandescent lamps that provide the most lighting in developing countries are also the least efficient. They are simple to install, cheap to manufacture, familiar to consumers, and widely available.

116. Fluorescent lamps are about four times more efficient than incandescent lamps, but their use in residences has been limited by their higher first costs, unattractive light, and inability to fit in incandescent fixtures. The compact fluorescent lamps more recently available, on the other hand, provide reasonably attractive light, fit regular incandescent fixtures and achieve an efficiency of 61 lumens per watt, or 3.8 times the efficiency of a comparable incandescent lamp. These new and innovative illumination technologies can significantly reduce the electric power capacity required to deliver lighting services in developed and developing countries. However, these technologies come at a high initial cost, which is a major constraint to their widespread use. Various incentives have been devised in developed countries to ease their entrance into the market place.

117. Refrigerators, both residential and commercial, appear to be inefficient in many countries. The stock of refrigeration equipment in developing countries is rapidly rising, making refrigeration and air-conditioning a major end-use application. The energy efficiency of food refrigeration equipment has improved tremendously in the past 10 to 20 years, and considerable potential for further improvement remains. These improvements were achieved by the use of more efficient compressors and fans, by the use of more and better insulation and by reducing the wattage of the anti-sweat heater.

118. In countries such as the United States of America, incentives to promote efficient refrigerators include rebates to customers who buy the most efficient models, as well as a "golden carrot" prize payment to the refrigerator manufacturer who develops a highly efficient model. At present, a golden carrot incentive programme is under way, in which consortia of utilities have pledged to provide $30 million to the first manufacturer who can commence commercial production of a super-efficient refrigerator which exceeds United States efficiency performance standards by an estimated 20 per cent.

(c) Sustainable construction practices

119. Energy is one of the most costly inputs to the construction process and energy use in construction and in buildings-in-use is a major source of

atmospheric pollution. The application of new energy-efficient technologies for construction and building use should, therefore, be an important element of any strategy for improving energy efficiency in human settlements and limiting the consequent atmospheric pollution.

120. The production of building materials consumes over 75 per cent of energy used in construction and much of this goes to the manufacture of a small number of high-energy materials such as cement and steel, burnt clay and concrete products, glass and plastics. The principal ways to improve energy efficiency in construction are by (a) improving the energy efficiency of high-energy materials production; (b) increasing the utilization of low-energy alternatives; and (c) increasing recycling and reuse of waste materials.

121. Several new technologies for improving the energy-efficiency of production of cement, steel and glass are now available in the international market, mostly in the private but some (notably, small-scale, vertical-shaft kiln technology for cement production) in the public domain, for transfer through outright purchase of equipment, licensing agreements or through joint ventures. In contrast, the production of bricks, tiles and lime remains highly energy inefficient and in urgent need of upgrading in many developing countries. Even though energy-efficient technologies such as continuous kilns to replace intermittent kilns are available internationally, in both the public and the private domain, the dissemination of these new technologies is hampered by the dispersed and small-scale nature of these operations, the majority of which function as micro-enterprises.

122. The second area of technological innovation is in the development of low-energy alternatives to high-energy materials. Three particular technology areas which have been widely investigated and are already the subject of substantial technology transfer programmes are (a) the use of pozzolans and other low-energy extenders in partial replacement of cement; (b) stabilized earth construction; and (c) structural use of secondary species of timber, seasoned and treated against biodegradation. All these technologies offer great potential for energy saving.

123. A range of new technologies are now under development in both industrialized and developing countries for increased recycling and reuse of waste materials in construction. The more promising among these include the use of phospho-gypsum produced as a by-product of fertilizer manufacture, the use of blast-furnace slag and fly-ash from coal-fired power stations, in addition to colliery and mine wastes and a range of agricultural wastes. Major factors which currently inhibit wider use of these technologies are the lack of information about these technologies, the problem of maintaining a steady supply of wastes to prospective entrepreneurs and the competitive use of the wastes by other economic sectors.

2. Mechanisms and measures to improve the transfer of environmentally sound technologies

124. Experience has shown that a decentralized and democratic decision-making approach that maximizes end-user participation and the use of local expertise in

the process of technological choice and in the design and implementation of projects, can be crucial in building the commitment to technology change that leads to sustainability.

125. Two areas need special attention. The first concerns a structural change in the pattern of resource use in human settlements. Pricing has been used successfully in some developing countries to promote environmentally sound technologies. There is a growing recognition of the efficacy of incentive-based economic instruments for programme implementation. They can reduce excessive reliance on regulation and public investment programmes to control pollution and stimulate innovation.

126. Another important concern is the provision of equitable access to environmentally sound technologies to all citizens, especially the urban poor, who are usually the first to be affected by the adverse environmental and health impacts of technology use. One way of achieving this would be to incorporate the social costs of all technology application options in cost-benefit analyses, as well as in pricing policies.

127. A publicly funded intermediary institution in the recipient country can provide a useful mechanism for selective acquisition and wide dissemination of environmentally sound technologies. However, it should serve as only one of many mechanisms for technology transfer, supplementing the mainstream transfer at the enterprise-to-enterprise level.

128. To minimize the risk associated with such transfer, developing countries might wish to focus first on mature and proved technologies (several biomass energy technologies fall into this category), which can be commercialized in local markets with little or no venture capital.

129. Efforts to promote environmentally sound technologies in human settlements should focus on two critical areas: reinforcing the flow of information to all stakeholders, and addressing capacity-building needs for evaluation and technology choice, using a participatory approach. Networking of existing institutions and building partnerships with non-governmental organizations active in this field could help leverage the limited available resources.

C. Freshwater 17/

130. Contamination of water resources in urban centres due to industrial development and rapid population growth and in rural areas due to chemicals used on intensively irrigated agricultural land has seriously affected the quality of both surface water and groundwater. An overriding objective in the transfer of environmentally sound technologies for water resources management is to prevent the pollution and degradation of existing water resources.

1. Main trends and critical factors

(a) Water supply and sanitation

131. The success of water resources development projects is strongly influenced by the availability of technologies tailored to meet local needs and conditions. A large body of useful technology lies in the public domain. There is an urgent need to improve developing countries' access to these technologies.

132. Important advances were made in the development and improvement of technologies for water supply and sanitation aimed at providing sustainable services at affordable cost to those people still without services: hand-pumps, disinfection, latrines, shallow sewers. It is, however, difficult to assess the impact of these innovations on the provision of services owing to a lack of reliable information on the extent of their application.

133. Desalination technologies for freshwater production have been developed and are in use. Rainwater harvesting is an alternative technique used for augmenting freshwater supplies and is quite widely practised, particularly for domestic water use.

134. Low-cost water technology applications are being promoted by various Governments and international organizations, particularly in rural areas. Appropriate cost recovery strategies for water saving will not only encourage greater efficiency of water use, but will also popularize wider utilization of water-saving technologies. Education of the public as well as easy availability of inexpensive water-saving devices are important in this context.

135. Rational development and management of water resources are important to overcome the problems of food production and development in rural areas in many parts of the world. The standard of planning, design, implementation and rehabilitation of water development projects in agriculture can be considerably improved by the availability of adequate technologies, techniques, methods and knowledge.

136. Wider application of new technologies depends to a large extent on public acceptance of the technology and the cost of alternate sources of water supply. Public education, pilot projects and dissemination of the available information will largely contribute towards wider public acceptance.

137. Although information systems and databases in the water sector exist, a large number of developing countries are still lacking information services. Notably, the lack of vital information on the accurate assessment of water resources and water use is a major obstacle in the sustainable development and management of water resources in many countries. Promotion of computer-based data storage and retrieval systems concerning both surface water and groundwater resources is an urgent issue in enhancing environmentally sound and sustainable development of water resources.

138. Past experience has shown that systems for improved water supply and sanitation have often failed because they were inappropriate or too sophisticated to be operated and maintained by local communities. Therefore,

the active involvement of local people, particularly women, in technology choice and the training of local personnel are crucial for the successful implementation and management of water and sanitation projects in local communities.

(b) Process water recycling 18/

139. A wide range of existing and new technologies are available for recycling process water. The possibilities range from simple straightforward recycling techniques, normally resulting in partial recyclability, to the application of such sophisticated techniques as ultra filtration and reverse osmosis that can upgrade polluted water to fully recyclable qualities.

140. When transferring treatment technology, it is important to adapt the transferred methods to the prevailing conditions in the receiving country. If the receiving country has limited experience in treatment technologies, a rugged and straightforward technique with low operating and maintenance requirements should be used.

141. The strategy in implementing transfer of environmentally sound industrial technologies or improvements of existing technologies in order to protect water resources should focus on the following:

(a) Minimizing pollution at the source by selectively recycling process flows or reusing process water at stages where a lower-quality water can be used;

(b) Finding applications for reuse of process streams that cannot be recycled within the process itself;

(c) Treating the minimized volumes of outgoing process water that cannot be either recycled or reused;

(d) Finding applications for reuse of treated outgoing process water;

(e) Controlling the availability and patent situation of the technology to be transferred before implementing the actions to be taken;

(f) Developing incentives that will increase the interest of the industry in implementing environmentally sound technologies;

(g) Establishing technology centres for the transfer of environmentally sound technologies, possibly in combination with demonstration plants. Both technical and economical advantages of the new environmentally more friendly technologies should be presented.

2. Mechanisms and measures to improve the transfer of environmentally sound technologies

142. Technologies transferred to improve water supply and sanitation systems should be adaptable to small-scale applications, suitable for community participation and management, and adaptable to local resources and traditional methods in the production, construction, installation and maintenance of systems available in the communities.

143. Incentives should be applied to stimulate the transfer of environmentally sound water management technologies and must be directed at two groups: the beneficiaries and the owners of technology.

144. Incentives such as charges on water users and polluters could also be applied, the funds generated being utilized for reinforcement of environmental management activities in freshwater resources.

145. Many developing countries are lacking national capabilities to undertake technology assessment and risk assessment. Advisory services to interested countries need to be provided and expert consultation on specific issues of common concern to a group of countries organized.

146. Private and public sector enterprises should be encouraged to make their contribution to cleaning up surface-water systems. Furthermore, ways and means of creating and expanding business opportunities in surface-water pollution treatment and in the management of water resources should be explored.

147. Concerted efforts should be made at the regional level in order to establish and develop expertise in the surveying and continuous monitoring of groundwater reserves in the region.

148. Coordinated activities aimed at the assessment of the various types of installed desalination technologies and their compatibility with particular environmental conditions could be the subject for possible activities by United Nations agencies.

149. Environmental education programmes at all levels would increase the environmental awareness of the general public and increase the pressure on Governments and industry to use environmentally sound technologies and methods to protect available water resources.

150. To implement the transfer of environmentally sound technologies effectively, the establishment of technology centres and/or demonstration plants is recommended. Technology centres can be supportive in adapting technologies to local conditions and offer excellent educational opportunities for technicians in the receiving country.

D. Toxic chemicals and waste management

1. Main trends and critical factors

(a) Liquid waste management 19/

151. Chemical and biological pollutants adversely affect human health and the environment. Heavy metals, organic solvents and toxic chemicals cause serious irreversible illness and increase mortality. The World Health Organization estimates that close to 80 per cent of all diseases and over one third of all deaths in developing countries are correlated with consumption of polluted waters.

152. In industrialized countries, the generation of liquid waste per capita per year exceeds 1,500 cubic metres; in developing countries, it is below 10 cubic metres per capita per year. Liquid wastes from urban and industrial pollution sources represent about 20 to 40 per cent of total liquid waste generation, but are the major sources of organic pollutants, heavy metals and hazardous toxic chemicals.

153. Technologies to prevent, minimize, treat, dispose and recycle liquid waste are well established. In a number of countries, programmes, policies, equipment, and operation and maintenance procedures for liquid waste management have been institutionalized. Traditionally, liquid waste management and treatment have been based on end-of-pipe technologies.

154. Treatment systems for liquid waste are often designed to handle very large volumes of waste, without any consideration to improvements in the processes that could reduce waste. Many plants end up with treatment systems that are too large to treat the waste efficiently. In some cases, the original intent of regulations aimed to conserve and recover was undermined by the more urgent need to comply with standards.

155. As technology has matured and efficiency of production has become more important, polluters have developed new wastewater treatment systems and also processes that are less wasteful. In many cases, the implementation of more efficient methods has resulted in the diminution of liquid waste from the processes. This in turn has made many of the wastewater treatment systems obsolete or inoperable.

156. From the wastewater treatment point of view, in locations where the weather is not extreme, especially the cold season, local governments are promoting the use of low energy, passive systems such as oxidation ponds, percolation fields and constructed wetlands because of the ease of operation and the low energy requirements. In places with more extreme weather, oxidation ditches with mechanical aeration is a technology often selected.

157. Tertiary and more sophisticated wastewater treatment is only required in very sensitive environments. Relaxation of the standards and recognition of the futility of separating combined sewers is an indication of the changes in the approach to waste treatment. Instead, the emphasis is being put on the treatment of potable water for human consumption. To meet these increasing

standards, techniques such as ion exchange, reverse osmosis and microfiltering are being implemented.

158. To try to address the change in emphasis on discharges, many Governments have been implementing a prevention component in their regulatory process. Pollution prevention, waste minimization and clean technologies are being encouraged. In order for these techniques to work, a more comprehensive approach has to be taken. Instead of looking at water pollution processes as a "black box", and worrying only about what comes out of the "box", efforts are made to look at each individual process and to reduce the pollution generated by this process. This approach necessitates significantly more varied expertise and coordination, and is therefore more complex.

159. Currently, in industrialized countries, Governments are implementing their water pollution control programmes with a strong bias towards pollution prevention instead of end-of-pipe treatment. Several large industrial conglomerates have demonstrated that pollution prevention is the most rational form of compliance. Savings from their efforts to prevent pollution usually cover the cost of the investment in a short time.

160. The world market for environmental pollution control exceeds $200 billion a year. Its growth rate is 5.5 per cent and is expected to reach $300 billion a year by the end of the century. The largest segment of the environment industry is the water and effluents treatment segment mainly because of significant government expenditures on municipal water and wastewater treatment plants. 20/

161. The effective transfer of environmental pollution control technologies goes beyond the formulation of plans and studies or installation of equipment. It requires the development of users' abilities to select technologies that genuinely address their problems and it requires appropriate economic and legal frameworks. Users of technologies should also have the necessary technical, financial and institutional capabilities. Therefore, effective technology transfer is based upon comprehensive analysis, local needs, internal resources supply, national restrictions for technology transfer, and infrastructure to operate and maintain technological systems.

162. Traditionally, technology transfer in liquid waste management has been carried out through a variety of channels, but mostly through the private sector. Technical cooperation from industrialized countries to developing countries has been conducted through sales of equipment, sales of patents and licences, technical cooperation from Governments, consulting services, training, joint ventures, or within transnational companies.

163. One of the more important aspects of the transfer of technology to developing countries is decision-making tools. Among these tools are environmental impact assessments, risk assessments, methods for selecting environmental control technologies, and environmental auditing and pollution prevention techniques.

164. The most significant critical factors affecting the transfer of liquid waste technologies are:

(a) Access to information on environmentally sound technologies;

(b) Monitoring and risk assessment;

(c) Environmental regulatory frameworks;

(d) Institutional capabilities;

(e) Financial barriers;

(f) Technical risk;

(g) Legal obstacles and trade barriers;

(h) Public support and awareness for sound decision-making.

2. Mechanisms and measures to improve the transfer of environmentally sound technologies

(a) International network of clearing-houses

165. An international network of clearing-houses for technology information and information referral should be established. An inventory of existing clearing-houses should be developed to help define the international network. Utilizing publications along with CD-Rom, Internet and other electronic media, regional clearing-houses should provide information to municipal and industrial water polluters on appropriate technologies for managing liquid waste.

(b) Demonstration projects

166. Demonstrations are needed to show the effectiveness and appropriateness of technologies to the specific country and industry/municipal application. Demonstrations can be designed to display an individual technique or technology or disseminate systems where know-how is shared first so that users can make an educated decision on the type of equipment to purchase.

(c) Case-studies

167. Reports can be disseminated about successful applications of environmentally sound technologies. The case-study should describe the application conditions so that potential users can assess appropriateness for their needs. Summary statistics about technical effectiveness, costs, return on investment, efficiency, operation and maintenance requirements should be prepared. Names and organizational contacts should be provided so that additional information on the case-study can be obtained.

(d) Environmental monitoring, measurement, planning and risk assessment

168. Environmental measurement and monitoring requires proper sampling and analytical methods and procedures. The path to good monitoring and measurement begins with appropriate sampling protocols, standard analytical methods, good

laboratory testing equipment, professional staff and provisions for quality assurance/quality control, and environmental data systems to interpret the results.

169. The technology for the acquisition of environmental measurements should be transferred to developing countries. Extensive documentation has been developed by industrialized countries on standards that may be applicable. Sharing of these standards, accompanied by expert training and capacity-building in the user country, could provide the proper basis for environmental monitoring, measurement and planning.

(e) Environmental regulatory frameworks and enforcement programmes

170. International organizations and multilateral and bilateral assistance programmes may wish to assign high priority to assisting countries in establishing and improving institutions as well as developing environmental standards and regulations tailored to the special environmental protection risks and priorities of individual countries.

(f) Strengthening local government institutional capability

171. Local government institutional capabilities need to be strengthened so that appropriate regulations and policies are adopted. These organizations need to establish implementing policies and procedures. At the national level, organizations need to provide specialized training for policy makers and for regional and municipal officials on policy-making and implementation activities.

(g) Economic incentives and regulatory measures that promote the transfer of environmentally sound technologies

172. Environmental regulatory frameworks may need to incorporate economic incentives, such as tax credits, pollution taxes, user fees, rapid depreciation schedules, liability policies and effluent fees, to encourage the development of new technologies or products and the adoption of cleaner production technologies and techniques.

173. Traditional environmental technology for liquid waste management has been biased towards end-of-pipe techniques that have a potential for simplistic and wasteful practices. Governments need to be cognizant of this and support policies that encourage pollution prevention, source control and proper management practices and procedures.

(h) Industry/government collaboration and support for the involvement of non-governmental organizations

174. Government and industry should work more closely to mix regulatory and voluntary measures to protect the environment. They can also work together to establish conflict resolution procedures to supplement formal legal enforcement measures and simplify compliance.

175. Non-governmental organizations also create demands for strong environmental programmes and a preference for cleaner products and production methods. Many

industries report annually on their environmental records. Providing non-governmental organizations with access to information on discharges associated with certain production processes can help stimulate the demand for environmentally sound technologies.

(i) Technical programmes that lower environmental costs and reduce problems with access to capital

176. The following actions are proposed to overcome some of the financial barriers related to the cost and transfer of environmentally sound technologies and problems with access to capital; these actions will assist dissemination and transfer of environmentally sound technologies:

(a) Promote industrial estates and clusters of industries (especially small and medium-sized industry) where environmental capital costs and operations and maintenance expenses are shared. Develop regional sewerage authorities where environmental costs are shared by several jurisdictions;

(b) Promote user fees for industry and commercial dischargers to support the operation of environmental programmes and facilities;

(c) Promote lending policies based on loans where funds paid back are used to make new loans. Improve understanding of industry, sewage authorities and consulting companies about the requirements of lending institutions for technical and economic feasibility analyses that support loans;

(d) Establish national waste exchanges, where waste from one factory is used as raw material at another or where wastes are cleaned and reused at other factories. Government and industry can also work together to encourage greater use of recycled products and create markets for new products made from recycled materials;

(e) Reduce discharges of toxic pollutants or hazardous or infectious wastes that reduce the beneficial uses of sludge from end-of-pipe treatment technologies. Sludge disposal costs and health threats can be substantially reduced.

(j) Strengthening institutional and professional capabilities

177. The following actions are proposed in order to strengthen institutional and professional capabilities:

(a) Develop environmental audit procedures and manuals, programmes for self-assessment of compliance and electronic systems for municipalities and for specific industries;

(b) Promote teaming between national and foreign experts, between national organizations and foreign corporations, including transnationals, and between foreign and national municipalities (sister cities) to exchange know-how and technology for pollution prevention and control;

(c) Conduct study tours of foreign specialists to industrialized countries to acquire hands-on skills and expertise with liquid waste treatment and prevention;

(d) Prepare manuals and implementation procedures for liquid waste management and treatment programmes. Conduct in-country training, workshops and technology fairs on environmentally sound technologies;

(e) Develop undergraduate and graduate university programmes on environmental science, engineering and planning;

(f) Establish networks of research centres focusing on environmentally sound technologies, pollution prevention and control of liquid wastes.

Notes

1/ Report of the Workshop on the Transfer and Development of Environmentally Sound Technologies, Organized by the United Nations Conference on Trade and Development (UNCTAD) and the Government of Norway, Oslo, 13 to 15 October 1993 (United Nations publication, Sales No. E.94.II.D.1); hereinafter referred to as the Oslo Report.

2/ See "Technology cooperation and transfer for improved energy efficiency", paper presented by the Governments of Colombia and the United States of America at the Meeting on the Transfer of Environmentally Sound Technology, Cooperation and Capacity-building, held at Cartagena, Colombia, from 17 to 19 November 1993; hereinafter referred to as the Energy Paper.

3/ Joint IDRD/Earth Council Workshop entitled "Research Priorities in Technology and Environment: Building on Agenda 21", Ottawa, Canada, 6-7 October 1993. See Summary Workshop Report entitled "Lessons and implications for IDRC".

4/ This section is based on the Oslo Report, except as indicated.

5/ See Anrita N. Achanta and Prodipto Ghosh, "Technology transfer in the context of global environmental issues", p. 186, paper provided by the Tata Energy Research Institute, New Delhi.

6/ The cost (approximately US$ 7,000 to US$ 10,000 per profile) passed along to the user is the actual cost to WIPO itself for contracting qualified analysts. If funds were made available from other sources, WIPO would be able to provide this information to the user at no cost or at a lower cost.

7/ See the report of the meeting of the Sustainable Development Task Force of the Society for International Development (SID), Ottawa, Canada, 10-11 October 1993.

8/ See "Transfer of technology: options for sustainable development", background document prepared for the present meeting. The document is a

condensed version of a forthcoming publication of the same title, prepared under the UNCTAD transnational corporations programmes.

9/ See World Bank, Environment Department, Global Environment Coordination Division, discussion note entitled "Mobilizing private capital against global warming: proposal for a venture capital fund for greenhouse gas mitigation", p. 1.

10/ David Jhirad and Irving Mintzer, "Electricity: technological opportunities and management challenges to achieving a low emissions future", In Stockholm Environment Institute Confronting Climate Change: Risks, Implications and Responses (Cambridge University Press, 1992).

11/ David J. Jhirad, "Implementing power sector solutions in developing countries", the Stockholm Initiative on Energy, Environment and Sustainable Development (SEED), November 1991.

12/ International Finance Corporation, note entitled "Investing in the environment: business opportunities in developing countries", p. 14.

13/ This section is based on a paper submitted by the World Health Organization, entitled "Transfer of environmentally-sound technology: dissemination of information on communicable diseases and their effective control", 1993.

14/ This section is based on a paper submitted by the World Health Organization, entitled "Transfer of environmentally sound technology: vaccination technology", 1993.

15/ This section is based on two papers, the Energy Paper (see note 2) and a background paper prepared by the United Nations Centre for Human Settlements (Habitat) on transfer of environmentally sound technologies for sustainable human settlement development, 1993.

16/ Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992 (United Nations publication, Sales No. E.93.I.8 and corrigenda), vol. I, Resolutions adopted by the Conference, resolution 1, annex II.

17/ This section is based on three papers issued in 1993: (1) Economic and Social Commission for Asia and the Pacific (ESCAP), "Transfer of environmentally sound technology on the Asia-Pacific region: "Freshwater"; (2) Food and Agriculture Organization of the United Nations (FAO), "Transfer of environmentally sound technology in freshwater"; and (3) United Nations Industrial Development Organization (UNIDO), consolidated response to the follow-up and reporting to the Commission on Sustainable Development on Agenda 21, chapter 18 on the management and use of water resources.

18/ See note 17, the UNIDO paper.

19/ This section is based on "Transfer of technology in the liquid waste sub-sector", presented by the Governments of Colombia and the United States of America at the Meeting on the Transfer of Environmentally Sound Technology, Cooperation and Capacity-Building, held at Cartagena, Colombia, 17 to 19 November 1993.

20/ The OECD Environment Industry: Situation, Prospects and Government Policies (Paris, Organisation for Economic Cooperation and Development, 1992).
