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REVIEW OF IMPLEMENTATION OF AGENDA 21 AND THE REGIONAL STRATEGY
ON ENVIRONMENTALLY SOUND AND SUSTAINABLE DEVELOPMENT,
INCLUDING TRANSFER OF ENVIRONMENTALLY SOUND TECHNOLOGY;
CLIMATE CHANGE AND POTENTIAL RISE IN THE SEA LEVEL;
AND FOLLOW-UP TO THE GLOBAL CONFERENCE ON THE
SUSTAINABLE DEVELOPMENT OF SMALL
ISLAND DEVELOPING STATES

(Item 5 of the provisional agenda)

TRANSFER OF ENVIRONMENTALLY SOUND TECHNOLOGIES

Note by the secretariat

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I. INTRODUCTION AND BACKGROUND

A. Introduction

1. The United Nations Conference on Environment and Development, held in Rio de Janeiro, Brazil in June 1992, adopted Agenda 21. That programme of action emphasized the transfer of environmentally sound technologies as an important means of implementing a comprehensive programme for environmental protection. It stated that "Environmentally sound technologies are not just individual technologies, but total systems which include know-how, procedures, goods and services, and equipment as well as organizational and managerial procedures."¹ While there may be some skepticism about the role of technology in overcoming problems that are, at their root, social and political, it is generally agreed that it is a critical variable in the overall strategy for sustainable development.

2. The deliberations leading up to and following the United Nations Conference on Environment and Development have given new impetus to the issue of technology transfer. During the 1960s and 1970s technology transfer was at the centre of development debates. More recent concerns over environment and sustainable development have again raised awareness of the need for developing countries to use various technology transfer mechanisms to achieve desired environmental goals. Progress has been slow owing to pressing issues of debt, macroeconomic adjustment and trade liberalization.

3. Success and failure of technology transfer depends upon endogenous capability. This includes capacity to assess and select the appropriate technology, to train manpower to undertake research and development (R and D), and to improve basic design engineering. Most countries in the region either do not have or have not used effectively the science and technology infrastructure which they have built for the development and absorption of technology.

4. International collaboration in environmentally sound technologies and promotion of their transfer to developing countries is a priority topic in global meetings. The Commission on Sustainable Development, at its third session, held in New York in April 1995, discussed three interlinked priority areas: (a) access to and dissemination of information on environmentally sound technologies; (b) institutional development and capacity-building for managing technological change; and (c) financial and partnership arrangements. A programme of work was adopted which basically urged the following: the conduct of surveys and assessments; the dissemination of well-documented case-studies; demonstration projects; networking including establishment or strengthening of environmentally sound technology centres; organization of training activities and workshops; undertaking joint venture and partnership projects; and promoting measures for strengthening cooperation within countries among the scientific and business community and government. Policy guidance was provided for technology cooperation and financing. These were also discussed in

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¹ *Agenda 21*, chap. 34.3.

various ESCAP forums. They need to be further analysed in the regional context so that activities can be designed for implementation at national level with regional cooperation as the focus. In addition, specific targets are to be set for capacity-building on environmentally sound technologies and options for financing transfer of environmentally sound technologies are to be examined. The regional catalytic effort will form the basis for technology cooperation. At the regional level, these issues are to be discussed mainly for promotion of regional cooperation and to facilitate capacity-building. These require further elaboration and assessment in order to incorporate them in a regional action programme.

5. The present note reviews the more important aspects of the transfer of environmentally sound technologies in the Asian and Pacific region, keeping in view the issues and current problems of implementing international conventions.

B. Environmentally sound technologies

6. While recognizing that technology alone does not provide answers to the challenge of sustainable development, there is a growing awareness that more sustainable modes of development must draw upon technology. Environmentally sound technologies or "green" or "clean" technologies are often defined as those that are required to modify or improve specific products or processes, that generate low or no waste for the prevention of pollution, and that make efficient use of resources in an environmentally sound and sustainable manner. The definition adopted in Agenda 21 is as follows: "Environmentally sound technologies protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes."² However, it should be realized that environmental soundness is a relative term. What is regarded as "sound" today may prove to be "unsound" tomorrow. In addition, it is situation specific. Nevertheless, it is possible to identify some general characteristics of the environmentally sound technologies. Thus, environmentally sound technologies are those which:

(a) Increase efficiency in the use of raw materials, energy, utilities, land and water resources;

(b) Eliminate or reduce the extent of harmful wastes generated during production, ensure minimum hazard to human health, and reduce the risk of possible climate change and depletion of the ozone layer;

(c) Recycle products after their use to produce the same or other marketable products;

(d) Increase rates of economic as well as employment growth in developing countries while protecting the environment;

(e) Enhance the overall quality of life.

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² Ibid., chap 34.1.

7. In the industrial and energy sectors, environmentally sound technologies would be applied on production and process technologies, as well as end-of-the-pipe technologies to protect the air, water and land for human health. In the agricultural, forestry, fisheries and rural sectors associated with natural resources, environmentally sound technologies would involve promotion of efficient use and environmentally sound management of resources, conservation of biodiversity and the minimization of the risk of degradation of the environment.

C. Market for environmentally sound technologies

8. Of all the disparities between the developed and developing countries, those concerned with scientific and technological resources are especially acute. In the development debates of the 1950s and 1960s technology was considered a public good. It was assumed that technology transfer would be a "natural flow" allowing developing countries to "leapfrog" over gaps between themselves and industrialized countries. By the mid-1960s it was realized that the earlier view of technology as a public good to be picked off the shelf was an illusion. Technology is not given away free and technology transfer is governed by a bargaining relationship between suppliers and recipients.

9. *Nature of the technology market in general.* The international market for technology in general is largely oligopolistic or even monopolistic. Transnational companies have command of most of the technologies which provide them with a competitive edge. The main objective in all operations involving transfer of technology is essentially maximization of profit. What is true for technology in general is also largely true for environmentally sound technologies. Granting that there are some technologies in the public domain, technology suppliers have virtually been able to combine ownership of technology, dominant market power, access to financial resources, and skilled personnel to extract advantageous agreements from developing country companies and Governments. Such agreements, bolstered by the provision of trade-related aspects of intellectual property rights (TRIPs) and trade-related investment measures (TRIMs) usually result in high costs to the recipients in terms of both finance and restrictive clauses.

10. *Diverging views of technology suppliers and recipients.* In general, discussions on the transfer of environmentally sound technologies tend to mirror earlier debates about technology transfer between developed and developing countries. Thus, developed countries tend to stress that companies in those countries (which are major suppliers of environmentally sound technologies) should be adequately compensated for R and D investments and that there can hardly be any across-the-board guarantee of concessional terms. There is also a preference for working through existing institutions for funding transfer of technology activities (for example, the Global Environment Facility (GEF)). The recipient countries, on the other hand, have often recommended that new funding institutions be established which would ensure an adequate voice for them. Developing countries have also maintained that concessional terms should be extended to all environmentally sound technologies and not limited to those related to global issues only.

11. *The global and Asian market for environmentally sound technologies.* The current and potential world market for the environmental industry varied from US\$ 250 billion to US\$ 380 billion in 1992. Worldwide spending on environmental protection is projected to reach US\$ 426 billion by the year 1997, growing at an annual rate of 8 per cent (see table 1). The market for wastewater treatment technology alone is estimated to grow from about US\$ 230 billion in 1994 to about US\$ 320 billion by 2000.³

Table 1. Global environmental industry
(billions US dollars)

| | 1992 | Growth percentage | 1997 |
|---|------------|----------------------|------------|
| United States | 134 | 6 | 180 |
| Canada | 10 | 11 | 17 |
| Mexico | 1 | 15 | 2 |
| Latin America | 6 | 12 | 10 |
| Western Europe | 94 | 7 | 132 |
| Economies in transition in Eastern and Central Europe | 14 | 14 | 27 |
| Japan | 21 | 8 | 31 |
| Australia and New Zealand | 3 | 9 | 5 |
| South-East Asia | 6 | 16 | 13 |
| Rest of the world | 6 | 8 | 9 |
| Total | 295 | 8 | 426 |

Source: "US environmental technologies export", Inter-agency study (Nov. 1993).

12. According to the most recent estimates, the Asian market for environmental technologies is worth about US\$ 60 billion in 1995 and is expected to increase to about US\$ 90 billion by the year 2000. Asia's growth has severely compromised the quality of the environment and the quality of life throughout the region. Almost all Asian countries have been urbanizing rapidly and growth has not been supported by appropriate levels of investment in basic infrastructure. For instance, the Asian Development Bank (ADB) estimates that water supply and sanitation alone in the region will require an investment of about US\$ 80 billion to US\$ 100 billion up to the year 2000. Demand for water infrastructure will grow rapidly over the next 10 years as economies expand and the expected increase in population will create an even greater strain.⁴ Similarly, the problems of solid waste collection and disposal have already reached crisis proportions and require urgent attention.

13. Mutuality of interest of suppliers and recipients. While developing countries in the region need to be aware of the substantial cost associated with transfer of environmentally sound technologies, there is some interest among technology suppliers themselves in augmenting transfer

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³ Anice Brown, "Market opportunities for cleaner technologies in the US" (The World Bank, 1994).

⁴ APCTT, "Establishment of IETC technology transfer network" (1995).

activities. Mutuality of interest has stemmed from the urge among suppliers to offset the rising cost of R and D and the need for extensive markets to recover these costs. There may also be substantial scope for supplier companies to benefit from process or product adaptations pioneered by R and D units of recipient companies. R and D capacity of the recipient thus facilitates such transfers. Developing countries may find it advantageous in some cases to deal with relatively smaller technology suppliers that may be more willing to enter into a mutually beneficial transfer agreement because of their own financial and human resource constraints. For more widely available, public domain technologies, the barriers are likely to be less legal and financial than informational. Mechanisms to increase the flow of such technologies might include donor Government funding of export development missions, particularly for small, specialized companies, and improved provision or support to brokering services.

II. RESPONSES AND SECTORAL ISSUES

A. Regional situation and constraints

1. Regional situation

14. In the past most of the countries in the region have pursued development through exploitation of natural resources and use of conventional industrial technology. The demand on resources has been aggravated by unprecedented growth of population and the need to improve the standard of living of the rural population.⁵ Small and medium enterprises, crucial to the economies of the region, have frequently found it financially difficult to address the problems of pollution. Additionally, policies pursued in the past often encouraged domestic protection and allowed continued adoption of environmentally unsound technologies that have resulted in increased pollution.

15. Lately, however, there has been increased liberalization of economies and a move towards greater reliance on the market mechanism. A significant number of countries in the region have also experienced an increase in foreign direct investment in recent years.⁶ Exposure to international markets and standards has encouraged these countries to introduce environmental legislation and policies to adopt environmentally sound technologies. It is realized that transfer of such technologies depends largely on the extent of development of absorptive capacities, but the region has considerable scientific and technological capabilities that can be shared among the countries for successful transfer.

2. Factors relating to major constraints on the demand and promotion of environmentally sound technologies

16. *Intellectual property rights.* Technology, and particularly proprietary rights over new and emerging technologies, is the crucial factor in determining comparative advantage, creating competitiveness and promoting economic growth and development in the producer country. It is the
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⁵ S. Behura, "Transfer of environmentally sound technologies", paper prepared for Consultative Meeting on the 1995 Ministerial-level Meeting, November 1994.

⁶ "Report of the Committee on Environment and Sustainable Development on its second session" (E/ESCAP/984).

source of important and increasing private benefits. It is also the most important asset of transnational corporations, which consider it as a powerful means to open up and control new markets. Therefore, the issue of intellectual property rights is a major issue in the transfer of technology debate. Technology producer countries believe that intellectual property rights should be strictly protected and strengthened in order to provide incentives for technological innovation. They also consider that effective protection of intellectual property is necessary for fair return to risk and considerable R and D.⁷

17. The issue of intellectual property rights is receiving growing attention in both developing and developed countries. This issue will have a strong impact on national industrial and technological development and intercountry relations, especially in the light of the agreement of the Uruguay Round of multilateral trade negotiations and the attention now being focussed on TRIPs. The relationship between intellectual property rights and flows of technology and capital is likely to vary substantially across countries in the region, sectors and types of technology. The new legal frameworks are likely to have the most influence in the countries where foreign direct investment is not limited to assembly facilities, but involves transfer and use of new technologies and undertaking of some R and D locally. Some of the most developed countries in the region have already taken steps towards increasing protection for intellectual property rights. Others still need to implement such standards and it is in such countries where the effects of the new regime may be more significant and costly to put in place.

18. Stronger intellectual property rights may certainly imply higher costs in terms of royalties and other payments, which may, in turn, reduce the resources available for local R and D. Moreover changes in intellectual property legislation could affect the bargaining position of potential contracting parties and make access to technology more problematic. Higher levels of protection could also deepen negotiating imbalance and lead to the imposition of abusive practices restraining competition. In view of the above concerns, the existence of a firm basis for regional cooperation in this area is obvious.

19. As regards TRIMs, many countries of the Asian and Pacific region have already introduced more liberal requirements on ownership and approval procedures, and provided enhanced incentives for foreign direct investment. These and comparable changes in other countries of the region reduce the possible impact of the TRIMs agreement. A basic issue is to what extent the implementation of the TRIMs agreement may influence the flows of technology and capital to developing countries of the region and the building up of their technological capabilities? If countries are forgoing the right to use their legislation to maximize technology components in capital flows, through for instance local component requirements, what should they do to induce a process of technology transfer that enhances their technological capabilities?

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⁷ "Implementation of Agenda 21 in respect of three cross sectoral cluster" (E/ESCAP/ESD(2)/3).

20. *Lack of awareness and appropriate information.* The demand for environmentally sound technologies is considerably impeded by the lack of information exchange between various interest groups on opportunities for pollution prevention. This is highlighted by the lack of political will and low prioritization accorded to this issue in government policies. A meaningful database that is accessible through on-line information retrieval systems on the availability and accessibility of environmentally sound technologies and their economic viability, and their suitability to the local environment, skills and raw materials is not yet available. Available databases lack crucial information such as on possible savings in raw material consumption and reduction in pollution control costs through the adoption of environmentally sound technologies.

21. Many environmentally sound technologies in use in developed countries do not have the features that make them functional in the developing countries owing to raw material and socio-cultural variations. In many industrialized countries this is partly aggravated by the lack of awareness and systematic information about the specific problems and conditions influencing technology transfer and application in individual developing countries. This lack of information is particularly severe for small and medium enterprises in industrialized countries that are interested in exporting their technologies.

22. Companies in industrialized countries wishing to inform developing countries about their technologies tend to use technical information brochures that have been issued for prospective clients in their own countries or in other industrialized countries. For developing countries, however, this information is frequently inadequate as the recipient countries may not have previous experience in related technologies or enough information on the economic aspects of the promoted technology. Improvements in the form of communication could increase the efficiency of the technology transfer.

23. *Increased cost and risk factors.* The most significant barrier to the demand for transfer of technology is the cost. Furthermore, the countries with the greatest need for cleaner technologies are often those with the highest level of foreign debts. The cost of implementing environmentally sound technologies may be substantially higher since it may require new investment. The cost differential between traditional and environmentally sound technologies becomes more apparent as polluters escape without having to pay for the clean-up owing to lack of enforcement of legal measures for pollution control. Unfair competition in markets owing to the lack of comparable environmental regulations and standards also poses a constraint on the environmentally sound technologies.

24. *Sub-optimal scale of industrial operation.* The protection offered to industry along with the emphasis on the decentralization of industrial development results in the implementation of sub-optimal scales of production, most notably in such sectors as pulp and paper, sugar and distilleries, leather tanning and the chemical industry. For many products, the capacity of a single plant in developed countries is larger than the entire installed capacity of the product in developing

economies, which itself is distributed in a large number of units. The adoption of small-scale production frequently increases the cost of production and pollution control, making it financially difficult for small companies to meet emission standards or shift to new production processes.

25. *Non-availability of specific industrial design parameters.* Plant-specific design parameters are crucial for newly introduced technologies. Proponents of such technologies in the developed countries often do not possess accumulated experience on specific design parameters for the effective transfer and application of these technologies to developing countries. As a result, technologies exported to developing countries are often not adaptable to local resources, infrastructure and the socio-political environment.

26. *Lack of trained human resources.* One of the major constraints to technology transfer is lack of trained manpower to adapt and implement environmentally sound technologies in developing countries. This may result in sub-optimal operation of such technologies, leading to cost-overruns, and may enhance the perceived risks associated with such transfers.

27. *Lack of research and development support.* There is an imbalance in levels of research and development and patent ownership between industrialized and developing countries. Technology developed in one country is not always suited or easily adaptable to the environmental and social needs of another country. Developing countries in the region often do not possess indigenous capability to create their own technologies, and to adapt existing environmentally sound technologies to their own specific needs, particularly with regard to high-tech and sophisticated technologies.

B. Selected regional and global responses

28. *Selected programmes for small and medium enterprises in the region.* The importance and dynamism of small and medium enterprises is one of the distinguishing features of the industrial sector in the region. They account for more than 50 per cent of the industrial sector output in China and India, and for 10-25 per cent in most other countries in the region.⁸ Unfortunately, sufficient data to analyse more carefully the relative concentration of small and medium enterprises in polluting industries (versus cleaner industries) in the region do not readily exist. However, it is recognized that such enterprises pose difficult pollution abatement problems and often pollute more per unit of output than large firms in the same sub-sector. The low level of managerial skills, technology and financial resources compounds the problem. Public sector leadership in providing incentives, information and common treatment facilities in this sub-sector is considered vital.

29. The United Nations system is helping countries build their own technical capabilities. More specifically, the United Nations Environment Programme (UNEP) and the United Nations Industrial Development Organization (UNIDO) are working together on a project to establish a number of national cleaner production centres in developing countries. The centres will seek to bring public and /...

⁸ World Bank, "Towards an environmental strategy for Asia" (1993).

private sectors together, and will play a coordinating and catalytic role in initiating cleaner production activities by providing technical information and advice, carrying out demonstrations of cleaner production techniques and technologies, and training industry and government professionals in industrial environmental management. During the first project phase (1994-1996), up to seven centres, funding permitting, are expected to begin operation. Ultimately, UNEP aims at building a network of such centres in all countries of the world.

30. The Asian and Pacific Centre for Transfer of Technology (APCTT) runs a technology exchange programme whose main objectives are to evolve new methodologies to develop national capabilities in technology transfer and utilization, assist small and medium enterprises in technology searching and enhance regional and interregional cooperation. Under this programme, the Centre has organized a demonstration of selected technologies from China and India in cooperation with the State Science and Technology Commission of China. The exhibition has paved the way for a large number of Indian entrepreneurs to seek the application of Chinese technologies. As a follow-up, the Centre also organized a specific technology negotiation meeting between the Technology Transfer Cell of China and the concerned Indian enterprises.

31. In 1991, UNEP launched the cleaner production concept and cleaner production network at a seminar hosted by the United Kingdom of Great Britain and Northern Ireland in Canterbury wherein representatives from various countries including those from the Asian and Pacific region committed themselves to work in partnership. In February 1993, it hosted the Asia and Pacific Cleaner Production Conference in cooperation with the Environment Protection Authority of Victoria, Australia. In October 1992, it held its second ministerial and senior-level seminar to review progress in cleaner production throughout the world and discuss the future orientation of the cleaner production programme in the light of the decision of the United Nations Conference on Environment and Development and Agenda 21. Both the World Bank and the Asian Development Bank (ADB) have initiated programmes of technical and financial assistance to address the problems, particularly in the areas of industrial policy, enforcement, small and medium enterprises and hazardous wastes.

32. The Food and Agriculture Organization of the United Nations (FAO) has a wide range of activities related to the maintenance of the productive capacity of natural resources for agriculture, forestry and fisheries (soil, water, genetic resources, forest resources, fish stocks). Other activities relate to the safe use of agro-chemicals and other technologies through the promotion of integrated plant nutrition systems, integrated pest management, renewable energy, waste recycling, pollution and food contamination control. People's participation is seen as being the key to successful transfer and acceptance of technologies by the farm communities. Such a participatory approach has been adopted by the UNDP/FAO/UNIDO Farmer-centred Agricultural Resource Management (FARM) Programme. The Programme aims at enhancing the capabilities of governmental and non-governmental organizations to improve the capacity of resource poor communities and farmers in Asia in the

conservation, management and utilization of natural agricultural resources through participatory approaches in order to eliminate degradation of natural resources, increase production and eradicate poverty in rainfed areas.

C. Sectoral concerns of the region

33. *Energy generation and use.* With Asia's high population and economic growth, energy demand is doubling every 12 years (the world average is every 28 years). The demand for electricity is growing even faster: two to three times faster than the rate of growth of gross domestic product (GDP) for the newly industrializing economies (NIEs) in the region and up to two times faster than that for most of South Asia. It is, therefore, necessary that aggressive energy efficiency programmes be integrated in the overall strategy of introducing environmentally sound technologies in the region. Increasing energy efficiency in end use technologies provides the most immediate potential to slow the growth of CO₂ emissions. More efficient domestic appliances, residential and commercial heating systems, and industrial electric motors would reduce the need for energy. As developing countries in the region create additional power generating capacity, much of which will continue to come from coal, they will need improved technologies such as combustion turbines, combined cycle systems, and cogeneration that can increase fuel efficiency by more than 25 per cent. Further reductions of CO₂ are possible by switching from coal to oil and natural gas. Over the short term, oil and gas technologies should be considered environmentally sound for countries that would otherwise use coal. Hydroelectric power already provides considerable amounts of non-CO₂ based energy, and wind energy, solar-thermal, and solar photovoltaic technologies are other viable alternatives. These technologies will become more competitive as technical innovations and economics of scale reduce their costs.

34. In the field of energy, the UNDP/ESCAP Programme for Asian Cooperation on Energy and the Environment (PACE-E) was launched at Beijing in October 1993 and a programme on "Natural gas utilization in transport" was started under a memorandum of understanding with the Association of South East Asian Nations (ASEAN); activities in coal development and utilization were implemented in June and August 1993. Under Asian Energy Efficiency 21, a training workshop on energy conservation as a business opportunity was held at Bangkok in December 1993. A major work done by the World Bank in the area of transfer of environmentally sound technologies relates to the review of the cost and status of selected renewable energy technologies, centring on the use of biomass for fuel and electricity, solar-thermal technologies and photovoltaic. This includes experience with renewable energy technologies in various countries and regions. The conclusion is that progress in renewable energy technology has been positive.

35. *Environmentally sound technologies for the energy sector.* Such technologies for the energy sector include:

- (a) Energy efficient equipment for energy conservation;
- (b) Control and measurement technologies to be employed in the development, production and use of energy efficient equipment;
- (c) Clean coal technologies, especially for countries such as China and India which rely on coal in meeting their current and future energy demand;
- (d) Solar energy technologies, comprising flat-bed collectors for domestic purposes, concentrating collectors in certain configurations for specific applications;
- (e) Efforts at better demand-side management for energy conservation and the prevention of energy loss;
- (f) Other renewable energy technologies including power generation from wastes.

36. *Agricultural sustainability and related issues.* Agricultural land and fishing marine resources in Asia are subject to intense pressure from farmers and fishermen (often at subsistence level) struggling to achieve food self-sufficiency. Forests and marginal lands are suffering from serious degradation for a variety of reasons. Asia thus faces the difficult problem of attempting to achieve higher production in agriculture and forestry without destroying remaining land, marine, forest, and habitat resources.

37. *Environmentally sound technologies for agricultural, marine and forestry sectors.* Such technologies for the agricultural, marine and forestry sectors include:

- (a) Advanced technologies such as genetic engineering, pest eradication, and breeding varieties of plants and animals that are more suitable to agro-climatic conditions;
- (b) Development of crop varieties and livestock breeds that are specially adapted to stressful agro-climatic and biophysical conditions; high yield technologies and management practices for intensive agriculture; and crop diversification;
- (c) New methods of farming such as integrated (or ecological/environmentally sound) agriculture;
- (d) Integrated pest management and environmentally sound fertilizers and methods of their application;
- (e) Environmentally sound technologies for efficient irrigation, for example, drip irrigation;
- (f) Soil desalination, stabilization and upgrading technologies;
- (g) Technologies for the safe use of pesticides;
- (h) Environmentally sound technologies for efficient agro-forestry;
- (i) Improvements in the area of marine biotechnology, and marine chemical and seabed mining.

38. *Problems of the transport sector.* The demand for urban transport facilities has increased far beyond the capacity of urban transport systems. The massive increase in motor vehicles, which are comparatively inefficient compared with other modes of transport, has resulted in significant pollution. Traffic jams have become common, leading to higher consumption of fuel and an increase in pollution. Countries of the region recognize the need to use improved technologies in transport infrastructure.

39. *Environmentally sound technologies for the transport sector.* Such technologies for the transport sector include:

(a) Lead resistant and non-noble metal-based catalytic convertors for automobile exhaust emissions control;

(b) Fuel-efficient engines for automobiles and other transport;

(c) Advanced technologies based on non-polluting fuels such as hydrogen, solar power and compressed natural gas;

(d) Optimal design of transport and traffic systems;

(e) Demand-side management, such as introduction of better communication technologies and better land-use planning/zoning involving less cross-city movement.

40. *Some special issues for the rural sector.* Introduction of environmentally sound technologies in rural areas and in their micro-industries would require a special approach, combining environmental regeneration with employment in small and micro-industries that are environmentally sound. Integrated programmes for introducing science and technology for the development of local skill and resources are required, including marketing outlets for products and services from rural areas. A large number of environmentally clean vocations which have migrated from rural to urban areas such as tailoring, weaving, spinning, baking, culinary arts. A movement is required to encourage environmentally concerned people to use produce from rural areas. The rural areas lack infrastructure such as electric power, roads, and communication. In addition to the traditional vocations mentioned above, possibilities for extending advanced technologies that are scale neutral, such as tissue culture and biotechnology can also be considered along with environmentally sound technologies for sustainable agricultural, marine and forestry sectors.

III. FACILITATING TRANSFER OF ENVIRONMENTALLY SOUND TECHNOLOGIES

A. Capacity-building

41. Capacity-building activities for transfer of environmentally sound technologies in developing countries in the region need to encompass several areas. For example:

(a) Capacity for needs assessment studies;

(b) Capacity for technology assessment and forecasting and the ability to choose the appropriate technology, keeping in view the current factor endowments and future needs;

- (c) Capacity to bargain in case of imported technologies for conditionalities which favour the recipient country or firm;
- (d) Capacity to adapt as well as develop new technologies through R and D;
- (e) Capacity to collate, disseminate and share relevant information on environmentally sound technologies using networking modalities along with available media channels and local extension services.

1. Capacity for national needs assessment

42. Developing countries in the region must have adequate environmental scientific capabilities if they are to make correct assessments of their technological needs. Acquiring relevant scientific knowledge regarding environmental issues should be seen as an essential counterpart to any action on technology transfer.

43. If properly designed, country-level needs assessments can themselves be an effective way of transferring data, expertise, and analytical capabilities to host countries. The experience of the Montreal Protocol on Substances that Deplete the Ozone Layer may offer important lessons in this regard. Under this Protocol industrialized countries volunteered to assist one or more developing countries in undertaking joint needs assessments, subject to a common framework developed at a workshop of participating countries.

44. For many developing countries, the financial, technical and logistical burden of national assessments may be overwhelming. There will be a need to explore more decentralized approaches, working at the regional or national level. Any needs assessment procedure must give careful attention to the methodology to be followed and the type of training provided to local counterparts. Needs assessment should not be focused exclusively on identifying possible technological solutions. As decades of experience in supporting research for development have shown, a successful intervention must start by identifying the needs of the local population to ensure that solutions are appropriate.^{9, 10}

2. Capacity for technology assessment and forecasting

45. Inappropriate technology choice, especially in case of imported technology, has been a long standing problem with several developing countries. It is imperative, therefore, that while considering environmentally sound technologies due attention be given to building capacity for technology assessment and technology forecasting. The following are important elements for proper technology assessment:

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⁹ Report of the Secretary-General on environmentally sound transfer of technologies, cooperation and capacity-building (E/CN.17/1995/17).

¹⁰ "Education, Science, Transfer of Environmentally Sound Technologies, Cooperation and Capacity Building", Letter dated 22 February 1995 from Permanent Mission of the Republic of Korea to the United Nations.

- (a) Awareness of socio-economic parameters;
- (b) Knowledge of alternate technologies and markets;
- (c) Ability to analyse alternative choices;
- (d) Knowledge of global markets and their constraints, including protectionist measures relating to trade and intellectual property rights, emerging global technological trends, and methods of assessing social costs.

46. Without adequate endogenous research and development capability in various facets of environmentally sound technologies, it is difficult to understand emerging trends and to analyse alternatives in the context of natural resources in a country and the production sector linkages in keeping with social preferences. Technology assessment is a complex exercise. Technology assessment studies should have reasonable representation from research and development groups, social scientists, technology assessment study groups in industry and government, social activist groups with access to various studies, and an active media to discuss the issues holistically and to communicate them to the public effectively.

47. The crucial problems that need to be addressed in technology assessment and forecasting are:

- (a) Capability of research and development institutions to conceptualize and develop environmentally sound technologies geared to the particular conditions and future needs of the respective countries;

- (b) Broad dialogue among and with various stakeholders in the development process, including government officials, financiers, industrialists, scientists, engineers, farmers and fishermen, to decide whether, and to what extent, a certain technology meets the specific conditions of the country, or whether its introduction may intensify and aggravate other problems facing the country;

- (c) Endogenous capacities for objective decision-making taking into consideration whether and how a coalition of necessary resources in the national framework and/or with international cooperation can be formed.

3. Capacity to bargain for conditionalities favourable to recipients

48. The recipient country or firm needs to have the knowledge of the "technology shelf" from the supplying countries as well as the latter's marketing potentials and constraints in order to strike the right bargain. It should also have the capacity to evaluate the costs and benefits of various technology contracting mechanisms such as turnkey contracts, joint ventures, know-how contracts, technology/process for the licensing. Since the most environmentally appropriate technologies for the developing countries are not necessarily the latest technologies, financial considerations are not usually a problem. The rapidly changing technology frontier, combined with intense competition among suppliers, may make suppliers more willing to transfer even very new technologies.

49. There are also some obstacles to negotiating a fair contract. As pointed out earlier, technology purchasers typically face extreme disadvantages *vis-à-vis* suppliers, in terms of their inadequate knowledge regarding domestic technology needs and the range of technologies potentially available to meet those needs. There are also informational constraints on the supplier's side. Young firms and firms working in emerging fields have a difficult time estimating potential markets. In addition, technology suppliers may find out there are few if any buyers, either because the field is still new, because the benefits of the technology have the character of a public good (with few individual buyers willing to become involved), or because the firm lacks experience in overseas markets. Technologies linked to external assistance with no option for choice of the technologies are also another impediment for the recipient country or firm. Thus, the negotiation is not always "loaded" against the recipient. The capacity to assess the potential strength and weakness in bargaining positions is an important resource which is often not seriously considered in a developing country.

4. Capacity to adapt and develop environmentally sound technologies through R and D

50. *Static versus dynamic transfer.* There is no automatic link between technology imports and the development of technological capability. Technology transfer can be distinguished in terms of technological content, that is, the knowledge, skills, and capabilities imparted to the recipient. In some cases, this technological content is relatively low, consisting largely of capital goods, engineering and managerial services, and product designs. In other cases, additional skills and know-how for operation and maintenance of imported technology are included. In both instances, only production capacity is transferred to the recipient. When the technology content is low and the recipient has gained the know-how only to operate and maintain, it may be classified as mere "static transfer". For "dynamic transfer" of technology, the recipient country needs to acquire the skills, and experience required to implement technical change either by altering the particular technological system or by investing in new systems endogenously developed based on earlier experience.

51. In essence dynamic technological capability refers to the skills, abilities, and experience needed to select, use, adapt, and create technology. Indicators of technological capability would include the following: the capacity of the recipient firm to define its technology needs and negotiate with suppliers; the ability to operate imported technology efficiently; the capacity to undertake routine repairs and maintenance; the ability to analyse production facilities and modify equipment to increase capacity and reduce costs, the ability to plan, design, and execute expansions of capacity; and the ability to generate a series of technological innovations to improve production.

52. *Linkages between R and D and the production sector for capacity-building.* While substantial research is in progress in the scientific laboratories of many developing countries, there is lack of coordination and direction in R and D efforts, and inadequate thrust for technology transfer from laboratory to commercial scale. These problems arise mainly because laboratories do not have a

mission-oriented approach and because of the inadequacy of design, engineering and fabrication facilities; the inadequacy of funds for pilot-scale demonstration of laboratory results; and the low value placed on technology transfer by scientific and technological personnel engaged in R and D.

53. Even in industrialized countries, once technology is developed and patented, it takes over two years for a plant to go into operation, and two to three years more before the plant is successful. Only after this stage is the proven technology exported. Ultimately, by the time technology is exported and the plant is commissioned in a developing country more than 10 years have elapsed and there is the risk that the technology is already being superseded by new developments. Thus, the advantage of well tried technology is lost. In essence, it may be more practical to import technology at the R and D stage and then develop it with the collaboration of the production sector.

54. Research and industry should work together, with laboratories working as think tanks for industry and industry turning laboratory innovations into industrial products. Viable R and D programmes are also essential for ensuring dynamic transfer of environmentally sound technologies. With the increasing role of the private sector in the region, it is necessary to involve private sector firms in endogenous R and D activities. The management of private sector and multinational firms should learn to participate responsibly in national dialogues and not act merely as pressure lobbies.

5. Capacity to collate, disseminate and share relevant information on environmentally sound technologies

55. *Environmentally sound technology centres.* In the Seoul plan of action concerning information exchange about environmentally sound technologies, formulated by a workshop on the promotion of access to, and dissemination of information on environmentally sound technologies, held in Seoul in December 1994, it is suggested that environmentally sound technology centres can play an important role in the promotion of environmentally sound technologies by providing regular assessment of user needs, initiating demonstration projects, helping identify public domain technologies and provide linkages between the private sector, international R and D and possibly financial institutions. The National Environmental Engineering Institute (NEERI) of India and the Korea Environmental Technology Research Institute (KETRI) are two examples of such centres in the region.

B. Overcoming the information barrier

56. Unless developing countries have the proper knowledge to make informed choices among environmentally sound technology options, efforts to promote international technology transfer will become overwhelmingly supplier driven rather than responding to the needs of developing countries. To begin with, countries need better access to information on the range and performance characteristics of given environmentally sound technologies. There are now a number of inventories, information services, databases and the like either in operation or in the planning stage to alter this fact. However, access to information may be limited by the insufficient capacity of recipient countries to use the available information. The design and implementation of information systems has to ensure

that the appropriate clients are reached, and that the appropriate tools are available to promote diffusion of the information within supplier countries. In addition, there may be considerable room for the involvement of intermediary institutions that perform a brokering service.

1. Establishment of effective information system and clearing-house

57. The existing national, subregional, regional and international information systems need development and linkages through regional clearing-houses covering broad-based sectors of the economy sector such as agriculture, industry and energy. A national clearing-house needs to be set up in all countries in the region. The clearing-house would disseminate information on available technologies, their sources, their environmental risks, and the broad terms under which they may be acquired. They would operate on an information-demand basis and focus on the information needs of the end-users. They would take into account the contributions of different national and international organizations. They would also take initiatives as and when necessary, to help users to identify their needs, and to disseminate information that meets those needs, including the use of news, public information and communication systems. The clearing-houses would provide not only information, but also referrals to other services, including sources of advice, training, technologies and technology assessment. The clearing-houses would thus facilitate the establishment of joint ventures and partnerships of various kinds.

58. The Seoul plan of action concerning information exchange about environmentally sound technologies emphasizes, *inter alia*, that there is a great deal of information about environmentally sound technologies available. However, the sources of that information might not be easily accessible or adequately described. A proposal was made to UNEP that a survey be made of information systems related to environmentally sound technologies. In its interim report submitted in April 1995, UNEP, which had surveyed 240 organizations, reported that nearly 60 per cent of the systems included information on pollution control technologies and only 22 per cent had information on cleaner production. It also found that nearly 40 per cent of the systems provided information free of charge. In the Asian and Pacific region, the systems surveyed included APCTT, NEERI, ENSICNET (Environmental Systems Information Center's Network) of the Asian Institute of Technology.¹¹

2. Establishment of information networks

59. Networking and technology brokering have emerged recently as key initiatives in technology transfer. These mechanisms make the transfer process faster and more effective. Networking is a cost-effective mechanism to assist industries in identifying technological partners (or future joint ventures) locally and abroad. The essential features of an effective network are strong links with industry and the high motivation of network members. Working together provides a critical mass
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¹¹ UNEP, "Survey of information systems related to environmentally sound technologies - Interim report", paper presented at the third meeting of the Commission on Sustainable Development, held in 1995.

with respect to the management of information and financial resources. APCTT has been actively working on establishing international partnerships and technology transfer networks for environmentally sound technologies and other technologies since the early 1990s. It has established, through UNDP funding, the Mechanism for Exchange of Technology Information (METI) as a regional network for collection and dissemination of information on environmentally sound technologies available for transfer to small and medium enterprises in Asia and the Pacific. Several ESCAP members (Bangladesh, China, India, Indonesia, Malaysia, Nepal, Pakistan, Philippines, Republic of Korea, Viet Nam) participated in the first phase. METI is open for participation by any country. The International Network for Transfer of Environmentally Sound Technologies (INTET) has also been formed by APCTT. The network, which is targeted at small and medium enterprises and technology consultants/brokers, is growing very fast as it helps enterprises to grow and compete in local and international markets. The INTET members are provided by APCTT with an integrated package of services which includes the following:

- Information on the technology, business and investment opportunities;
- Search for business partners worldwide;
- Technology financing;
- Consultancy subcontracts;
- Marketing assistance;
- Participation in technology transfer events organized by APCTT.

60. Information on environmentally sound technologies and cleaner production is provided by APCTT to INTET members on a regular basis. This makes it possible for the environmental education of small and medium enterprises to be continuous. APCTT is forming alliances with various cleaner production centres to provide INTET members and other clients with information and training on such aspects as environmental management ecologically-friendly product development and waste reduction. APCTT has provided the opportunity for increased technical cooperation among countries and speeded up the flow of information on technology by pooling resources and sharing experiences.

61. The International Environmental Technology Centre (IETC) was officially established in April 1994 in Japan, with its two offices operating as a single integrated unit. The office in Osaka deals with general urban problems, while that in Shiga deals with freshwater issues. The objective of IETC is to promote the transfer of environmentally sound technologies to developing countries and countries with economies in transition through the provision of training and consultancy services, conducting research and accumulating and disseminating related information. Through IETC, UNEP will further assist developing countries in gaining access to and analysing the usefulness of technology to address complex environmental problems, thus bridging a critical gap in carrying out the mandates of Agenda 21.

62. As a first set of activities, UNEP/IETC and the United Nations Centre for Human Settlements (Habitat)/Sustainable Cities Programme have embarked on field-level projects in China to assist in the identification of local needs for technology transfer through the development of local Agenda 21 in cities where environmental degradation has reached or may reach serious levels. These activities will form part of the network of the Sustainable Cities Programme, whose goal is to mobilize technical and financial resources from both bilateral and multilateral sources, promote an exchange of know-how, the sharing of resources and the development of common tools and joint actions between cities in different regions of the world. By joining with the Programme, UNEP/IETC can offer participating cities a proven methodology of integrated planning and bring the added dimension of helping to identify environmentally sound technologies to address specific environmental problems.

C. Policies to promote environmentally sound technologies

63. Agenda 21 called for, in chapter 34, new policies and programmes to promote and facilitate transfer of environmentally sound technologies along with attendant consideration of cooperation and capacity-building. It outlined five broad objectives:

(a) To help to ensure access, in particular of developing countries, to scientific and technological information, including information on state-of-the-art technologies;

(b) To promote, facilitate, and finance as appropriate, the access to, and the transfer of environmentally sound technologies;

(c) To facilitate the maintenance and promotion of environmentally sound indigenous technologies;

(d) To support endogenous capacity-building, in particular in developing countries, so that they can assess, adopt, manage and apply environmentally sound technologies;

(e) To promote long-term technological partnerships between holders of environmentally sound technologies and potential users.

64. Policy instruments used by Governments in the region to control environmental damage are important means for augmenting demand for adoption of environmentally sound technologies by industry. Policy makers have an array of instruments at their disposal to control environmental degradation. These instruments can be broadly classified into direct regulations and economic instruments which make use of the market mechanism and price incentives. Many countries in the region have developed environmental policies that draw heavily on the regulatory group, which is consistent with the traditional path followed by developed countries as well. However, it is now worthwhile to study special features of market based instruments which may augment demand for environmentally sound technologies.¹²

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¹² Anil Markandya and Julie Richardson, eds., *Environmental Economics*, (London, Earthscan, 1992).

65. *The relative efficiency of market-based instruments.* The main market-based instruments to control environmental externalities are taxes and emission permits or quotas which are freely tradable. An optimal pollution tax or charge would oblige the polluter to pay the full cost of the environmental services they consume and will be set equal to marginal damage costs at the optimal externality load. These permits are freely tradable, and in principle can be bought and sold on a permit at the going market price. The pollution standard is therefore determined by the supply of pollution permit which can easily be adjusted.

66. Faced with emission charges or the price of emission credits the cost-minimizing firm will seek ways to reduce pollution, either via output reductions or investment environmentally sound technologies. In addition, market-based instruments provide continuing incentives for the polluter to search for cost minimizing ways of abating pollution and in this sense are technologically dynamic and will augment demand for environmentally sound technologies.

67. Given the attractiveness of market-based instruments and opportunities for practical implementation via the pricing and standards procedure, Governments may take actions to integrate them into their environmental control package. The potential cost savings are typically very large and certainly are sufficient to justify the trouble of moving away from the status quo.

68. It is also being recognized that market-based reforms on their own may be insufficient to alter the prevailing situation. Thus, more traditional "command and control" type regulations (pollution standards, regulatory practices) may be essential in at least some fields, particularly where price mechanisms do not function adequately. Financial or technical bottlenecks also slow the shift to cleaner technologies. In such cases, public sector financial assistance, or publicly funded R and D, may play an important role.

69. Economic policies which discourage the application of environmentally sound technologies and encourage wastage and inefficiency should be reviewed. They include highly subsidized raw materials, energy and natural resources and cost-plus pricing of industrial goods. A system of incentives should be devised to facilitate the adoption of environmentally sound technologies, investment in environmentally sound technologies and the phasing out of obsolete and highly polluting technologies. Incentives may be in the form of tax exemption, rapid depreciation allowance for introduction of environmentally sound technologies, and other commonly used incentives to attract investment into priority areas.

70. *Experience of some countries in the region.* Malaysia achieved successful results in phasing in pollution charges for palm oil and rubber factories. Fees, first levied in 1978, were raised incrementally until 1984, by which time, technological breakthroughs had occurred in palm oil effluent treatment technology. The Government of India has decided that all new automobiles to be sold from March 1995 onwards must have catalytic converters. This has generated demand for this technology among the manufacturers, and APCTT has been requested to locate technology partners

in developed countries for this environmentally sound technologies. Indonesia has substantially raised domestic fuel prices (reduced subsidies in almost all petroleum products) in recent years and expects that the environment would benefit from more efficient use of petroleum products.¹³

71. *Clean technology pays - demonstration.* UNEP has studied the introduction of environmentally sound technologies at the plant level in many sectors. It has recently published a compilation, *Cleaner Production Worldwide*, which presents 14 cleaner production studies in 12 countries and 14 different industry sectors. Among the examples were a textile plant in India which stopped using highly polluting sodium sulfide in dyeing processes and substituted hydrol, a waste stream from the maize starch industry. This process change required no capital expenditure. Another example comes from a UNEP-World Bank project in which 67 low and no-cost options were implemented in seven plants at a cost of US\$ 16,500. This saved US\$ 350,000 and at the same time reduced pollution by 50 per cent.¹⁴ Cost-benefit analysis for selected industries in India given in table 2 have been used to demonstrate that investment in environmentally sound technologies involving recycle and reuse pays for itself. Such demonstration can help augment demand for clean technologies in other countries.

Table 2. Cost-benefit analysis for selected industries

| Industry | Total waste water flow (m ³ /dia-meter) | Total cost of plant US dollars | Net annual recovery US dollars | Investment payback period (years) | Remarks |
|-----------------|--|--------------------------------|--------------------------------|-----------------------------------|--|
| Apparel | 6450 | 147 000 | 139 000 | 1.05 | Recycle in process |
| Alcohol | 1725 | 71 400 | 31 000 | 2.30 | Reuse of energy in process |
| Tanning | 2710 | 123 000 | - | - | Recycle for irrigation |
| Food processing | 1460 | 335 500 | 135 000 | 2.47 | Recycle for irrigation/process and reuse of energy |
| Viscose rayon | 4500 | 1 350 | 1 140 | 1.18 | Recovery and reuse of zinc, foreign exchange savings |

Source: V.S. Kulkarni, Naraswat and P. Khanna, "Development and implementation of cleaner technologies in India, *Journal of Indian Association for Environmental Management*, vol. 18, Nos. 1 and 2 (February-June 1991).

72. *International conventions as tools for transfer of environmentally sound technologies.* International conventions provide a useful means of encouraging the transfer of technology. For example, article 9 of the Montreal Protocol on Substances that Deplete the Ozone Layer provides for the contracting parties to cooperate in research and exchange of information on the best technologies for containing or destroying ozone depleting chemicals. Several provisions for transfer of environmentally sound technologies are incorporated in the Basel Convention on Transboundary Movements of Hazardous Wastes and their Disposal.¹⁵

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¹³ The World Bank, "Indonesia - sustaining development", report No. 11737 - IND (1993).

¹⁴ V.S. Kulkarni, et. al., "Development and implementation of cleaner technologies in India", *Journal of Indian Association for Environmental Management*, vol. 18, Nos. 1 and 2 (1991).

¹⁵ OECD, "1995 progress report on implementing Agenda 21". (1995).

73. Generation and application of technological solutions and implementation of international conventions to counter the effect of accumulation of gases in the atmosphere containing chlorofluorocarbons (CFCs) have been relatively expeditions and has become a standard against which pace of implementation of other international conventions may be judged. Early scientific evidence regarding harmful effects of CFCs lead to the Vienna Convention (1985), the Montreal Protocol (1987), and more recently, amendments to the protocol in Helsinki (1989) and London (1990). The international community has agreed to terminate production and use of CFCs over a specified time period. Firm agreements were also concluded on transfer of best available related technologies supported by financing modalities. However, for other international conventions which require transfer of environmentally sound technologies, the initiatives so far taken by developed countries have not been encouraging. Very few institutional or financial mechanism have been proposed to achieve the objectives in the conventions while no time frames to achieve them were prescribed. Similarly, there is no indication of how financial resources would be raised.

74. *Special role of transnational corporations.* Technology is often best transferred through a commercial transaction between enterprises which is of mutual benefit to both parties. Transnational corporations play a special role in accelerating technology transfer as technological capital is concentrated within the transnational corporations.¹⁶ For example, 90 per cent of all technology and product patents worldwide is held by transnational corporations. They are also an effective channel for such transfer because technology transfer by transnational corporations is processed as a whole including building a trained pool of manpower and infrastructure. Transnational corporations are, obviously, profit motivated sources of technology (including environmentally sound technologies). Problems and criticisms notwithstanding, licensing contracts with transnational corporations continue to be one of the convenient modes of transfer of technologies. It should be noted that many transnational corporations have emerged as leaders in voluntary environmental responsibility schemes. They have also started environmental responsibility programmes individually or through international industry associations and national industry groups.¹⁶ Taking into consideration the motivation and the momentum of environmental responsibility programmes of transnational corporations, the relevant partnership between government and the private sector, particularly with transnational corporations should be established in the policies to promote environmentally sound technologies.

D. Financing transfer of environmentally sound technologies

75. There is a clear need for technical assistance and institutional lending to encourage and support environmentally sound technologies. The multilateral financial institutions and bilateral assistance programmes are becoming increasingly active in this area. Many of the agencies of the United Nations are promoting cleaner production and efficient resource management with focus on technical assistance and provision of information sources. The current mechanism of financing is not /...

¹⁶ UNCTAD, "Environmentally sound technologies-options for developing countries". (1994).

explicitly for financing of environmentally sound technologies, rather this objective sometimes is imbedded into projects with development objectives. There is also a need for a targeted approach to financing transfer of environmentally sound technologies.

76. Large industrial enterprises normally finance transfer of environmentally sound technologies as a consequence of regulatory and economic instruments introduced and enforced by Governments as well as influence of increasingly environment-sensitive international markets. Indeed, the influence of regulatory mechanisms on financing of transfer of environmentally sound technologies by manufacturing and venture capital companies in the region is increasing.

77. Establishment of environmentally sound technology rights banks has been suggested to help finance transfers from corporations holding patents and process licences of environmentally sound technologies. Similarly national environmental funds are needed to be established as they can play a significant catalytic role in improving environmental management in who are often found to be major polluters in the region. Official development assistance (ODA) remains an important source of funding for transfer of environmentally sound technologies. Several venture capital companies worldwide have selected environment as the main area for their investment. APCTT has formed partnerships with many of them to facilitate transfer of environmentally sound technologies in the region. APCTT is matching technology transfer partners and runs a finance syndication process involving several partners.

78. The issues regarding financing transfer of environmentally sound technologies were put forward in the third session of the Commission on Sustainable Development. In particular, the mechanisms proposed were international capital flows in the form of foreign direct investment. Other mechanisms appeared in the form of public-private partnership of technological and financial intermediaries, build operate and transfer arrangements, the technology triangle concept involving government agencies and institutions, private sector and science and technology research institutions, and environmentally sound technologies venture capital funds. Taking the lead from these proposals, the countries in the region may join together for pooling their own resources to promote R and D through the existing R and D organizations.

IV. RECOMMENDATIONS

79. In addition to national initiatives, the regional organizations such as ESCAP and ADB, together with the World Bank, UNEP, UNESCO, UNIDO and UNDP, can play a critical role in the promotion of environmentally sound and human resource compatible technologies in the region by evolving appropriate mechanisms for the development and dissemination of indigenous and location-specific technologies.

A. National actions

80. The following actions are suggested for national implementation:

(a) *Need for a new policy framework.* It is necessary to devise a policy framework at the national level which will influence the technological considerations preceding investment decision-making in such a way that resource utilization as well as the cost of environmental protection and damage are minimized while economic productivity and the innovative capacity of industry are maximized. In other words, the new policy framework should look for transfer and development of environmentally sound technologies that reduce or eliminate harmful emissions during the production process itself. Appropriate policy changes should be made to encourage the private sector to invest in R and D and manpower development as distinct from near-total and yet inadequate investment by the Governments. "Command and control" policy instruments should gradually be replaced with "market based" instruments which are likely to augment demand for transfer of environmentally sound technologies.

(b) *Special consideration for small and medium enterprises.* In Asia small and medium enterprises produce a major share of industrial pollution. They need to be given special consideration in the overall national strategy for transfer of environmentally sound technologies. Financial institutions that assist such enterprises should ask for environmental impact studies on an appropriate scale prior to project funding. Environmental expertise should be made available for this purpose.

(c) *National environmentally sound technology needs assessment survey.* Countries should embark on assessment of their technological needs, particularly for environmentally sound technologies.

(d) *Human resources development and capacity-building.* Human resources development programmes for the promotion of environmentally sound technologies should offer interdisciplinary training in scientific, engineering and social aspects of environmental management with a specific focus on requirements in the areas of agriculture, industry, energy, health and human settlements.

(e) *R and D collaboration.* National Governments should examine the potential for the following:

- (i) Public domain technologies, which include those technologies published in technical journals and presented at technological conferences. However, most of the information in this domain tends to benefit those who are already engaged in institutionalized R and D. The small operators who do not have knowledge about the conversion of technical information to productive use rarely visit the information centres that have been built for them;

- (ii) Abandoned technologies, which include technologies available in expired patents, could also be viewed as intermediate solutions in developing countries;
- (iii) Research by-products generated by multinational firms which generally use less than 5 per cent of their proprietary investigations and patented innovations.

(f) *Environment funds.* National environmental funds are needed to be established as they can play a significant catalytic role in improving environmental management and help the introduction of environmentally sound technologies. The funds can be set up as foundations, trusts, endowments or grant-making facilities.

B. Regional actions

81. The following actions are proposed for regional implementation:

(a) *Regional programme for the promotion of environmentally sound technologies.* A regional programme aimed at enhancing national capabilities for the assessment and application of environmentally sound technologies would make it easier for the countries of the region to keep up with global developments (in line with Agenda 21) and attract associated investment. The regional programme may include the following:

- (i) increased public involvement in environmentally sound technologies through organization of regional workshops and seminars on environmentally sound technologies and technology selection with the participation of non-governmental organizations, and the public and private sectors; publication of information booklets, pamphlets, journals, textbooks and handbooks on environmentally sound technologies;
- (ii) focused activities on transfer of environmentally sound technologies such as identification of those most suitable to different groupings of the developing countries of Asia and the Pacific;
- (iii) undertaking of sectoral studies on the use of environmentally sound technologies with the assistance of regional and international organizations;
- (iv) setting up demonstration projects for environmentally sound technologies;
- (v) periodic review of progress achieved in the implementation of the programme areas of Agenda 21 related to environmentally sound technologies and report to the Commission on Sustainable Development and legislative bodies of other international organizations active in the region.

(b) *Strengthening of national efforts through regional initiative.* There should be a strengthening of technology assessment and related environmental impact assessment capabilities at the national level through the regional networking of existing institutions, including those in the

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private sector. The importance of environmentally sound technologies owned by the public sector has been recognized and members should establish incentive systems or measures to promote their transfer from developed to developing countries. For example, led by the United States Agency for International Development (USAID), the United States-Asia Environmental Partnership (US-AEP) was founded to assist in addressing environmental degradation and sustainable development issues in the Asian and Pacific region by mobilizing United States environmental experience, technology and practice. The programme brings together the resources of 25 United States Government departments and agencies and thousands of businesses and non-governmental organizations that work with 34 countries and areas in the region. Furthermore, similar arrangements on the basis of technical cooperation among developing countries (TCDC) could be promoted for the transfer of environmentally sound technologies among developing countries.

(c) *Harmonization of intellectual property rights legislation at regional level.* Recognition of intellectual property rights is essential to the development of much-needed technologies. The TRIPs agreement is expected to favour a process of harmonization in legislation and practice relating to intellectual property rights, but not lead to uniform law on such rights. This provides the opportunity both to keep formulations at the national level that take into account various levels of economic and technological development as well as to use the TRIPs agreement as a basis for further harmonization of legislation at the regional level. Thus, the countries of the Asian and Pacific region might consider initiating a process of development of common legislative standards on intellectual property rights, based on the TRIPs agreement and reflecting the situation of the various groupings of countries that belong to the region. They may also foster intraregional cooperation in the training of personnel for administration and enforcement of intellectual property rights, and even to undertake jointly certain tasks (for example, search and examination of patent applications).

C. International actions

82. The following actions are proposed for international implementation:

(a) *Strengthening of supplier-recipient relationship.* Considerable linkages between research institutions and technology users in productive sectors are crucial and should be a key focus of donor efforts to strengthen local systems of innovation. A number of possible actions can be taken to strengthen the innovative capabilities of developing countries. Twinning programmes between the institutions in developed and developing countries; enhanced scholarship support to developing country students; project and/or core support to existing scientific institutions; policy advice regarding the reform of incentives to private-sector research; enterprise-level training in improved production design, maintenance and quality control: these are all examples of incremental, independent actions which can and should be pursued by a variety of actors.

(b) *Networking of technology assessment capacities.* For the national Governments or private sector organizations aiming at global markets, networking can help minimize the risks of a subsequent rejection of certain technologies they may develop with considerable investment of both money and human resources. For those who import technologies, such networking can increase their level of confidence about the suitability of technologies for their users. The benefits from networking will depend on the fair practices of various stakeholders in the exchange of information. If such networking of technology assessment capacities for environmentally sound technologies can lead to some special commercial treatments for sound technologies (for example, making them either free or available at nominal cost), the networking process will be further strengthened.

D. Financing

83. The following actions are suggested for consideration:

(a) *Financing of international efforts.* International environment funds, such as GEF, are necessary to set up projects based on environmentally sound technologies to demonstrate their techno-economic viability. At present, GEF is restricted to only four objectives: depletion of the ozone layer, global warming, biodiversity and international waters. In addition to the treaties and programmes covering these areas, GEF could discuss the possibility of support for such areas as efficient utilization of coal, and introduction of non-petroleum based transport, as long as they are related to the four objectives. Such funds should be used for: capital costs, including equipment, local adaptation, installed expenses, licensing fees, etc.; operating and maintenance expenses during installation and testing phase; training and support expenses in the initial years; and R and D expenses for regional/local adaptation.

(b) *Innovative financial mechanisms.* Some of the additional innovative mechanisms for financing development and transfer of environmentally sound technologies which could be considered are:

- (i) *Earthcare bonds.* Such bonds would be used to build up a fund for implementation of Agenda 21 by investing in environmentally sound technologies after providing a modest return to bond-holders.
- (ii) *International tradeable permits.* Tradeable permits and consumption rights relating to, for example, carbon emission should be on a per capita basis and not on the level of consumption and should be used to finance the introduction of new environmentally sound technologies.
- (iii) *Venture capital fund.* The World Bank has recently proposed establishment of such a fund to accelerate transfer of environmentally sound technologies. The number of such funds should be increased.

- (iv) *Debt-for-nature swaps*. The idea is to transform debts of developing countries into finance for introduction of environmentally sound technologies. This idea has had limited success so far but it is laudable and worth further deliberation.
- (v) *Debt conversion schemes*. These could be considered in economies which have since improved and in which debt-for-nature swap is no longer an option.

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