

## Clean technologies and hemispheric cooperation

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This paper provides a background document for the working group preparing recommendations for the Meeting of the Ministers for Science and Technology in the Americas. The general objective of the meeting is to strengthen and increase hemispheric cooperation in science and technology as an important instrument for contributing to sustainable development. This paper intends to contribute to the development of policies and proposals for hemispheric cooperation by providing: (i) a frame of reference by means of a succinct description of the main issues, (ii) from the above, and based on an examination of major obstacles, the development and applications of clean technologies, and (iii) priority areas for coordinated and cooperative efforts in the hemisphere to promote technological innovations for sustainable development.

### Background

In recent years there has been increased concern about the environment, and it is believed that unless the impact of economic activities on the environment is reduced, environmental constraints can limit the scope for economic development (World Commission). While there have been earlier occasions on which limits to economic growth have been put forward (Rath and Herbert Copley), the current set of concerns is new and focuses on the ability of sinks to adequately dispose of a growing volume of wastes and on the linkages between poverty and environmental degradation.

The concerns relating environment and development were addressed at the highest levels at the United Nations Conference on the Environment and Development (UNCED) at Rio de Janeiro in 1992. The final report of the UNCED conference is a useful starting point for the global consensus on the dimensions of the problem and the principal avenues towards their solution. It recommends a two-pronged approach in which priority attention must be given to greater employment and income opportunities for the poor, and also simultaneously, the ra-

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te of use of natural resources and the concomitant degradation of the natural environment must be slowed down and ultimately reversed.

Some of these issues identified as priorities at the UNCED conference, have also been emphasized at the Miami Summit of the Americas (1994). The leaders agreed that guaranteeing sustainable development and conservation of the environment were priorities for the hemisphere, and they agreed to cooperate to promote pollution prevention and sustainable energy use. They have also emphasized the important role of science and technology for achieving these objectives, and the need for cooperation. It is anticipated that the meeting of the Ministers in March, 1996 will develop more concrete actions plans for hemispheric cooperation which can then become part of the agenda for the next summit of the Americas in 1996.

## Concepts

### *Technology and Sustainable Development*

The process of discussions and negotiations leading up to the UNCED conference at Rio established certain propositions regarding the issues of technology and the environment which are now widely accepted in all countries. It is useful to note here that in the larger global discussions on the environment, there have been some differences of approach between the more industrialized countries and the developing countries, both of which are represented in the hemisphere; and issues of technology have resulted in some of the strongest disagreements between countries. However, we will illustrate below that technology-related issues also provide some of the best opportunities for mutually beneficial cooperation. It is apparent that if the efforts of the developing countries to take action to protect their environment are to be successful, while at the same time increasing their rates of economic growth and alleviating poverty, the solution must lie in the greater use of more appropriate technology.

It is generally agreed that the following facts apply to the prevailing circumstances:

[...] in the absence of technical change, environmental degradation will increase; degradation of the resources will force productivity to decrease. If developing countries adopt the obsolete, resource-intensive techniques used in the past by the North to industrialize, the levels of environmental damage will be high. It is important that developing coun-

tries avoid the earlier resource-intensive development phase as much as possible, and “leap frog” to the most efficient modern technologies available. Most technological development occurs and will continue to occur in the more industrialized countries; therefore, technological cooperation is a necessary condition for sustainable development. Effective technological cooperation will require increased and redirected technological efforts and capabilities in all countries. Technological change will need to be complemented by means of economic, political and social change. The private sector will be the main developer and user of most technologies, and governments need to set environmental goals and will play a crucial role in the speed and depth of development and dissemination of est (Environmentally Sound Technologies). (Barnett).

In these discussions, technology is defined as the combination of knowledge, organizations, procedures, machinery, equipment, and human skills that produces socially desired products. Changes in most components are generally required to make changes in a desired product, process or service. Change is introduced either by completely new technologies or through a process of incremental technical change. The latter is often neglected in discussions because it requires local resources at the level of firms and sectors not easily purchased from abroad but which have to be developed locally. The adoption of new technology is a complex process which requires for its success adaptations to local conditions, continued improvements over time, and the capabilities to generate further technological change in the future. (See Rath and Herbert-Copley; and Barnett.)

### *Environmental Technologies*

Environmental technologies are a broad group which include:

- *end-of-pipe technologies* which are added to a plant to treat pollution after it has been created;
- *remedial technologies* which are aimed at cleaning up or reclaiming currently damaged resources;
- *clean, or more appropriately, cleaner technologies* that are designed to reduce the amount of energy and raw materials needed to produce, market and use products and services.

The so-called *clean* technologies focus on minimizing the release of a potentially harmful contaminant to the environment by preventing pollution and reducing wastes at the source in the first place instead of subsequently dealing with the pollution generated. They may include

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process technologies that introduce major changes to the core technology to achieve environmental benefits; product technologies which modify or introduce new designs; and new specifications of final or intermediate products, to reduce materials and energy use and replace hazardous materials by less hazardous ones.

### *Clean Technologies*

The labels “Clean”, “Green” or “Environmentally Sound Technologies” (EST) are those which modify or improve products and processes at the source to minimize environmental impact. These terms are often used interchangeably and there is no attempt to distinguish between them here. Generally, a technology can be considered clean and environmentally sound if it:

- increases economic growth and expands employment opportunities in developing countries, while being sensitive to the resource endowments and product or service needs of these countries;
- increases efficiency in the use of raw materials and energy;
- eliminates or reduces emissions of harmful wastes generated in production and ensures minimum hazards to human and environmental health; and,
- promotes the reuse and recycling of inputs and end products.

### *The Cleaner Production Paradigm*

The sequence of responses to the environmental pollution problem has moved full cycle. The initial response was to ignore the problem; the next approach was to dilute and disperse the pollutants. When that also proved inadequate, the approach used was to control the ‘end-of-pipe’ emissions. For two decades, the easiest and simplest, though not necessarily cheapest or most effective technological solution was to control emissions after the fact with add-on devices, or to disperse the waste through higher smoke stacks or other means. Finally, and most recently, we have seen the emergence of the “cleaner production” paradigm because ultimately the newly identified environmental concerns are not amenable to “end-of-pipe” solutions, or to better dispersal or disposal methods. Problems of global warming, ozone depletion, loss of habitat and biological diversity all require a change of production techniques, a reduction in materials and energy throughputs, more ef-

efficient production, changes in the final products and also in the consumption ethic. All of these concepts are embedded in the newer approach of cleaner production, pollution prevention and industrial ecology.

Cleaner production technologies provide a more fundamental and basic approach to dealing with environmental degradation derived from economic activities. The concept is applicable and relevant to manufacturing and agricultural activities, as well as to hospitals and hotels and other economic activities. Clean technologies also provide developing countries with additional possibilities of “leap-frogging” over the older, more polluting path for growth taken historically by more industrialized countries.

In circumstance in which the needs of richer and poorer countries are in greater agreement, cleaner production and technologies provide solutions. The former are provided with the means of tackling their currently high level of waste production, and the latter, with an approach which enables them to solve the problems of poverty and to achieve economic growth, without degrading their natural resources.

#### *Elements of the Cleaner Production Methodology*

Cleaner production is a combination of several different approaches and is a multi-step repetitive process (UNEP, USEPA). It starts with the acceptance at national and organizational levels of the new concept that the best way forward is by the adoption of “cleaner production” and pollution prevention. At the national level, it requires the identification of major problem areas and sectors for priority action. When there is commitment at management level, resources are assembled to audit and assess production processes. The team designs flow charts of the entire operation, records all material and energy inputs, and the process outputs, and by products at each operational stage. These material flow and balance data are used to draw up an initial list of cleaner production options.

These normally include:

- Identification of obvious and short-term waste reduction, good housekeeping, recycling and reuse options;
- Characterization of problem waste and development of medium and long-term options to improve process efficiency, to modify products and processes for waste reduction, and to increase efficiency including R&D as required;

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- Technical, economic and environmental analysis of cleaner technology options;
- Implementation of selected options;
- Monitoring and evaluating results and re-analysing production processes.

Process integration, where entire production stages are re-examined, and discrete stages are combined, while some are eliminated altogether, has proven to be a successful approach to reducing material and energy consumption, and sometimes capital and work in progress, as well.

The cleaner production philosophy is embedded within a new paradigm of the Production Systems Approach called Industrial Ecology. The new paradigm is modeled on ecological principles and emphasizes the need to understand the material and energy flows in industrial systems, their effects on the environment, and the inter-relationships among technologies, regulations, fiscal policies and operational practices on these flows. Industrial ecology incorporates the analysis of entire process flows, recycling of waste, life-cycle of products, all considered from the initial product and process design stage, keeping the minimization of environmental impact as an objective.

#### *Examples of Cleaner Production*

Many examples are now available in which cleaner production approaches produce 'win-win' situations for firms, the economy and the environment. One machine tool factory spent \$350,000 on redesigned processes to meet environmental standards and recovered \$900,000. Monsanto and Dupont, both chemical companies, have been able to save hundreds of millions of dollars annually and significantly reduce discharges of pollutants through the use of these principles. UNEP provides 30 case studies of examples of cleaner production in 15 sectors from 30 countries, providing evidence that the principles and approaches are applicable to all sectors and in all countries. A few cases from the set will serve to illustrate the general principles and their applications.

An Austrian printed circuit-board manufacturer saved over \$1 million (2% of total revenues) and over 50% of the acids used, by applying process analysis and good housekeeping. In Chile, a textile dying plant used new monitoring and recycling technology for distillation, fermentation and energy re-cycling resulting in savings of over \$5 million per year. In Denmark, a cotton bleaching plant replaced reducing agents

by an enzyme-based process resulting in a \$15-30 cost reduction per ton of fabric. In France, an equipment maker replaced chemical cleaning by thermal scouring. In India, a small paper producer introduced a series of process modifications and new technology to achieve higher quality and reduced pollution, and attained cost savings of \$120,000 per year. Another small producer was able to save \$35,000 per year with an improved furnace design. In Holland, a new product design reduced costs by 50%. A group of projects in the Philippines indicated a savings of 10% in costs and a 50% reduction of emissions. Many examples of the cleaner technologies approach applied in different sectors can be provided. In the US, government, industry, and research laboratories undertook a year-long joint exercise to develop cleaner technologies for the printing industry. This effort focused on smoke-stack emissions, water discharge, and the chemicals used. The cooperative effort sought solutions through changes in issues related to regulations, technology and financing.

The general conclusion from all these cases is that the application of cleaner production technologies starts with simple audit procedures, and moves on to improved housekeeping. This is often followed by product and process modifications, and the application of new principles in science and technology. In many cases such application leads to reductions in pollution levels by 50 to 100%, to reduced use of energy, water and other materials, and at the same time, to increased economic gains with returns on investments within a few months or a few years.

There are a few efforts in Latin America, especially targeted at small and medium enterprises (SMES), which have reported similar promising results. The PROPEL project in Colombia assisted 300 SMES in Bogota engaged in leather tanning. Through the adoption of recommended measures, the project reports that there has been a 50% reduction in discharge of suspended solids, a 30% decrease in water consumption, an increase in profitability of \$2.00 per hide, resulting in a return on expenses incurred by the firm within 1,5 months. A similar effort by INSOTED, Ecuador, reports positive results for 120 SMES in the chemical, food, and tannery sectors. Initiatives by the Cámara de Industrias de Costa Rica and by SENAI in Brazil, have been reported without giving details on the coverage and impact. *It would clearly be an important initiative for the OAS to review and document such national efforts in the hemisphere and promote the sharing of experience and learning.*

### *Scientific Inputs for Clean Technology*

It is important to clarify at this point that clean technologies also involve and require major scientific and technological inputs beyond the initial step of process audits and good housekeeping. Some of the technological changes involve improving process and product designs, taking advantage of newer knowledge and better practices. Others rely on entirely new inputs from the latest advances in biotechnology, monitoring, information and control technologies, new energy sources and advanced materials. *To incorporate the latest scientific knowledge in the development of clean technologies requires changes in the way R&D priorities are set, as well as the organization of coordinated research on environmentally critical technologies and the establishment of research and industry consortia and networks.*

Enzyme technology, a new area of research and applications, for example, can gradually replace many chemical industrial processes. Enzymes work best at mild temperatures and conditions. They can be used to replace harsh conditions and chemicals, thus saving energy and preventing pollution. They are also highly specific, which means fewer unwanted side-effects and by-products in the production process. Enzymes can also be used to treat waste consisting of biological material, and in addition, are biodegradable.

In starch processing, for example, enzymes have largely replaced the use of the strong acids and high temperatures once used to break down starch. Enzymes could have a major impact on several other branches of industry. For example, in the extraction of vegetable oil from oil seeds, a new enzymatic process under development is intended to replace the current technology, which uses highly explosive and poisonous hexane.

In tanneries enzymes can replace the harsh chemicals used to remove waste from animal hides, and also treat tannery waste. Similarly, in the pulp and paper industry, the use of enzymes in pulp bleaching can boost the effect of bleaching chemicals and reduce the amounts of chlorine or chlorine compounds. In the future, enzymes may be able to replace bleaching chemicals completely. In detergents, many of the ingredients can be replaced by adding enzymes, which are 100% biodegradable, while still maintaining the same performance.

Enzyme technology is only one example in which the development of clean technologies must go beyond simple housekeeping into basic fundamental research. Other new technology areas of wide application would include renewable energy sources, fuel cells, biomass

combustion and its use in non-energy applications, information technologies, advanced materials and many others.

The environmental soundness of technology is a dynamic and relative concept. A technology deemed "clean" today may lose this status when a better alternative is found in the future, and a good alternative in one area may not be appropriate for another. Moreover, a technology considered benign may be seen to be damaging once all of its consequences are known. And for a given environmental problem, a plethora of cleaner technologies is possible, so it is difficult to make a master list of "clean technologies" to be supported. "Soft" technologies such as management practices and know-how are as important as such "hard" technologies as tools, machinery, and equipment. *The best choices will vary by sector and place, and will depend on needs, resources and technological capabilities available. Where clean technologies improve emissions while reducing costs and generating employment, they should form the core of technologies to be selected, adapted, developed, or transferred in a hemispheric program.*

### **Stimulating technology applications and removing barriers**

Access, demand and financing for clean technology, and the requisite policy framework, technological capability, infrastructure and relevant institutions for disseminating and utilizing the technologies are all areas to spur action to different degrees in all countries. To achieve faster rates of desirable technical change in hemispheric countries, attention must be devoted to three, often overlapping, issues:

- the development of new technologies and practices relevant to local conditions;
- the application of more efficient, cleaner existing technologies, on a wider scale; and
- the improved efficiency with which both old and newer technologies are operated.

Effective policies must integrate measures to stimulate the supply of cleaner technologies, which will increase the demand for their application both by the users and firms.

### *Increased Capacity in S&T*

There is a need both for increased scientific and technical skills, and for increased research capacity in the countries of the region if

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new knowledge and technologies are to be generated. There is also a need for R&D work in a number of areas in order to develop solutions for specific problems, as well as for priority setting exercises to redirect scientific effort in the required directions. The utilization of scientific and technological knowledge is facilitated by linkages between producers and users of knowledge. Such links are often weak or non-existent within many developing countries and ways must be found through new international technology co-operation programmes to create linkages with enterprises.

Technology strategies must also contend with the increasingly "science-based" nature of technological change in many fields, which requires increased collaborative efforts both within and among countries. New technologies and increasing rates of technological change provide opportunities for "leap-frogging", which should be attempted as a matter of policy.

#### *Increased Hemispheric Co-operation*

Within the hemisphere, more industrialized and less industrialized countries often have different perspectives on the issues of the environment; many developing countries are concerned about possible conflicts between environmental goals and their national development goals. Yet, there are emerging signs that a focus on clean technologies, which are better for the environment and for the economy, can achieve consensus among countries. There is increased recognition that any effective strategy must involve technological co-operation, among which training, experience sharing, networking and co-operative research and information systems are critical; and that efforts must increasingly focus on the so-called "soft" technologies, such as regulatory structures, regulations, industrial and competition policies, management practices, and so on.

Many existing bilateral programmes will have to be redirected to the new goals and incorporate new participants, particularly the private sector and production organizations, keeping the requirements for technological co-operation in mind. In some areas, particularly the support for the demonstration of new large-scale technologies, new resources will have to be found, and new mechanisms for demonstration and risk insurance will allow greater and earlier adoption via market mechanisms. Cooperative activities for developing and using clean technology are a costly activity, but much less costly than independent

and uncoordinated efforts. They have the potential for major benefits for all parties involved in the cooperation programme, stemming from the enormous potential magnitude for commercial technological transactions in the developing countries. Very large percentages of the new capacities in certain sectors such as energy, pulp and paper, aluminum and other primary sectors, will be installed in developing countries in the near term. The benefits include not only those accruing to the firms utilizing the cleaner technologies in question, but also spill over to the supplier firms, and the supplier and the recipient countries. These include:

- expansion of export opportunities for spare parts, auxiliary equipment and related products or technology;
- increased efficiency of the transfer process itself;
- enhanced competitive position of supplier firms vis-à-vis international competitors; and
- two-way flows of knowledge.

#### *Demand Side Measures*

Improved progress in technology development, use and application can be achieved in two main ways: by strengthening the supply side, and by strengthening the demand side. There are the direct means of support of technological development, such as research, development and demonstration (RD&D), definition of new research priorities, technological networks, information exchanges, and dissemination and training programmes to utilize new technologies. However, such supply-side options must be combined with measures to increase the demand for new technologies in the hemispheric countries.

A number of strategies can increase the demand for new and improved technologies: for example, removing the barriers for their dissemination, setting standards that require newer and cleaner technologies, modifying markets, putting into practice legal and institutional structures that reduce the demand for innovations, eliminating price distortions and special subsidies on inputs which result in the continuation of inefficient practices and sometimes make cleaner technologies less rewarding, stabilizing investment and regulatory systems and making them more transparent to attract financial resources, and sometimes providing market-based incentives at various stages of development and/or use of new technologies.

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### *Regulations*

*Environmental regulations, regarded as drivers of demand in the OECD countries, are either weak or lacking altogether in many countries of the hemisphere.* Increasing standards of efficiency and emissions are considered to be the driving force behind the achievements of considerable gains in efficiency within firms, and of market penetration of cleaner alternatives in many sectors. In a survey of firms with environmental technologies, the OECD reported that they find that the lack of demand for clean technologies in many countries stems primarily from the lack of appropriate environmental standards and regulations. In the industrial sector, regulation can be classified into two types: 1) specified compliance, which depends on specific rules and tends to result in end-of-pipe technology; and 2) negotiated compliance, which depends on flexible guidelines and bargaining. The latter is favored by industry and is thought to promote more productive modifications to the core technology. It is important for many of the hemispheric countries to develop standards appropriate to their circumstances, as both overly strict standards and a complete lack of standards can equally militate against the adoption of clean technologies.

### *Finance*

Financial constraints are particularly important. In the area of cleaner technologies, a key problem is often the lack of demand for their application; as a result, existing and readily available solutions are not applied as widely as would be desirable. Obstacles include lack of access to financing and weak environmental regulations. For many immediately attractive, economically and environmentally-efficient technologies, inadequate financial structures fail to direct investments and recapture the costs from the savings stream. In such cases, what is required is the availability of intermediary institutions like the energy services consulting firms (ESCOS), operating successfully in some industrialized countries.

Solutions will require many major developments, of which restructuring sectors, increased private, international financial participation, and changes in macro-policy are important. Several measures, such as increasing energy efficiency and improved housekeeping measures in industry require an initial investment, but also have high rates of return. Such efficiency improvements require a variety of institutional

measures. One example in the energy sector is the growth of energy service companies, which have emerged in the OECD countries. This is a major organizational and institutional innovation that needs to be shared with the developing countries.

#### *Subsidies and Market Distortions*

The elimination of market distortions, the removal of subsidies, and institutional restructuring can release significant financial resources, but all require initial provision of resources to overcome various obstacles to increased use of clean technologies. Acceleration of present moves in the countries to realign prices will increase both the demand for conservation and efficiency, and the demand for cleaner technologies, as well as generate much-needed financial resources.

#### *Information*

Many companies, especially those operating in environmentally sensitive industries, and smaller companies, are concerned that reducing environmental damage means substantial investment of resources. These costs are seen by many as likely to affect their costs, profitability and competitiveness in a negative way. But there are many examples where the “cleaner” technologies paradigm overturns traditional concepts and the application of many cleaner technologies are clearly “win-win” solutions for the companies, in that they reduce the environmental impact while at the same time increasing overall efficiency, reducing costs and resulting in higher profitability and competitiveness. While a few examples are provided here, it is important to document many more cases from the hemisphere, classified by country, by specific technology application and by sector of use, and to disseminate this information, specially to SMEs, to increase their knowledge and develop the confidence levels of entrepreneurs in adopting cleaner technologies.

Technology purchasers typically face obstacles, including inadequate knowledge regarding both technology needs and the range of technologies potentially available to meet those needs. A requirement is to provide adequate, ongoing assessments of technological needs. One possible point of entry in this area may be by means of the needs assessments that are being undertaken in a few countries with bilateral support. If properly designed, country-level and sector-level needs

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assessments can themselves be an effective way of increasing information, expertise and analytical capabilities in developing countries, as shown by the work done for the Montreal protocol and for the energy sector in some countries.

The most common topic to come up in the interviews involving researchers, policy makers, regulators and industrial firms with reference to obstacles, is that of lack of appropriate information. The same point is made by many firms in industrialized countries: although they possess innovative technologies, they have not previously been involved in developing countries. This is one area where there is a need for more detailed studies of what is available, which users are taking advantage of the services, who is being left out and what specific information needs there are.

There are informational constraints on the supplier side as well. In any new and emerging field, the nature of future applications is not immediately apparent, making the estimation of potential markets difficult. Most OECD member countries already promote some level of information exchange, both with other OECD members, and with developing countries. It should be noted that each of these groups has very different information needs, and a single arrangement may not be adequate for both. Canada and the USA have several excellent mechanisms for co-ordinating information on technologies in place, which can easily be expanded to allow easier access to hemispheric countries in their priority ranges.

### *Networking*

Networks, consortia and alliances differ widely in terms of institutional form, conditions of membership, and objectives (precompetitive research and technology development; standard setting; joint service provision). For the purposes of the discussion, at least three sets of consortia should be distinguished:

- *Existing networks for technology development.* These tend to be dominated by large technology-intensive firms and institutions. While there will be some merit in fostering regional participation, it will only be possible in critical areas of opportunity where the potential regional market size warrants it.

- *New international networks for technology development.* One possibility worth exploring is the scope for new networks or consortia (both South-South and North-South) focused specifically on environ-

ment and development problems facing developing countries of the hemisphere. Examples could be in solar and other renewable energy technologies, and, technologies relevant to key sectors in the region.

- *Localized, problem-solving networks around local firms.* There is considerable scope to support such joint efforts to overcome environmental problems in sectors which are important in developmental terms, have high levels of environmental impact, and are dominated by smaller firms (e.g. tanning; textile dyeing, some agro-industrial concerns). Localized alliances could help to diagnose problems, and work with outside agencies (including development banks) to implement packages of solutions. It is worth noting here that a first meeting of firms working in the area of agro-food processing is being convened in Uruguay under the auspices of the OAS with Canadian support to discuss their needs and possible cooperative arrangements to share information and technological experience.

There is also considerable scope for technology co-operation among non-competing users to solve common problems. This is the case, for example, with a proposed network of utility companies in North America, Europe and Japan, called the E-7, which is developing co-operative programmes in some countries on cleaner energy. In the case of emerging technologies and pre-commercial research, significant progress can be made in funding research partnerships between developing countries and industrialized country researchers in both public and private sector institutions. Some existing bilateral programmes have moved in this direction and provide interesting models in this regard. The US has several interesting technology development and dissemination programs under way, in partnership with several developing countries. These are so far more oriented towards Asian countries, and some of them could be initiated for the Americas. At a more ambitious level, multilateral efforts might be made to fund pre-commercial research in specific areas, such as biomass use or clean energy technologies. There is increasing scope for the participation of some of the larger firms from the more industrialized countries in such schemes, but the limited scientific capabilities of many countries of the region will make this difficult for other firms without public sector support mechanisms.

### *Market Stimulation*

Ultimately, ensuring an adequate flow of technology depends on global efforts to create a market for environmentally sound products

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and services. Governments can also have a considerable effect on more rapid technology adoption by the judicious use of procurement provisions in public sector investment. Both the USA and Canada have set out principles of public sector procurement which will lay down standards favoring cleaner products and processes. Here, hemispheric co-operation can help by pooling markets, not only nationally but regionally, thereby increasing scale, encouraging efficiency and reducing costs. This will require hemispheric co-ordination to set joint standards for products, services and technologies.

Learning about the experience of other countries in the use of different policy instruments can be an area for co-operation. Because of the technical and administrative requirements of regulatory actions, regulations should be used selectively. *One potentially important area of co-operation is in the design of regulatory systems appropriate to the conditions and administrative capabilities of the individual countries in the region. For this there is a need for "twinning" and similar co-operative arrangements between public institutions in the region.*

## Recommendations for cooperation

### *Directions for cooperation*

The cooperation efforts must be geared to promote technological change towards greater environmental sustainability. The status and level of technological capability in a country will depend on the knowledge acquired through basic research, the diffusion or transfer of new technologies both within and across national boundaries, their adaptation and incorporation into productive activities, and the process of incremental improvements to production systems. The ultimate goal of developing cleaner technology lies not in applying particular technological solutions, but in enhancing the capabilities of countries and more specifically, the economic agents to select, import, assimilate, adapt, and create the appropriate technologies. Moreover, efforts to develop the internal technological capabilities in the poorer countries need to be given appropriate importance.

Financial, informational, and institutional constraints constitute the most immediate barriers. However, for real progress, attention must be paid to social, political, structural and economic issues, as well as to technological ones. Both technological and social innovations are required. Technology is by no means a panacea for reversing environmental degradation, but it remains essential for the diagnosis of

environmental problems and for the design of strategies in the search for solutions. Finding a balance between roles and responsibilities of the state, between business and civil society, is a requisite for a reorientation of technology aimed at harmonizing environmental and developmental concerns. Social and economic structures influence the nature of technological change, and conversely, new technology has influence on society and economic production.

Successful hemispheric cooperation requires the cooperation among richer and poorer countries, more industrialized and less industrialized countries, and larger and smaller countries. To achieve such cooperation the environmental priorities must be decided on keeping in mind individual country priorities and that the resources required for dealing with them must be shared appropriately.

For the technologies which are especially relevant to the smaller and poorer countries of the region, special measures will be required. These needs should be made more widely known to researchers and technology suppliers in industrialized countries, and special efforts must also be made to support increased research and application in the countries where the applications are expected. To list detailed priorities, one must have better estimates of environmental costs and the likely economic, financial and environmental benefits by sector. Instead of a prioritized list, the approach taken here is to provide a list of promising directions for possible technology development and co-operation. The purpose is to stimulate and help guide the ongoing dialogue on how regional international collaboration may help accelerate the pace of adoption and dissemination of existing cleaner technologies, and how to ensure that future technology development efforts address the needs of the member countries and includes the participation of smaller and poorer countries. This report should enable the working group in cooperation with the OAS to further identify specific activities for greater attention and to select individual and groups of activities that could be pursued within future programmes of cooperation.

### *Recommendations*

Priority elements for an action programme should address:

- the lack of information, awareness and adequate training which are acute problems in poorer countries and for SMEs;
- the initiatives to support national regional and sectoral institutions providing access to information about, and assessments of, technologies, paying special attention to the poorer countries and smaller firms;

- sector-level studies of environmental management and adoption of cleaner technologies (what are the environmental challenges in specific sectors? What range of technological solutions is available? What are the main incentives for and barriers to adoption of new technologies? How do improvements in environmental management affect firms profitability and competitiveness? What is the scope for new financial or institutional arrangements to promote cleaner technologies?);
  - focus on the dissemination of existing “cleaner” technologies, and the absorption of technology at the local level;
  - documentation of existing initiatives in environmentally oriented technical assistance;
  - development of regulatory structures and enforcement mechanisms;
    - actions to facilitate the transfer of technologies, know-how, and experience for public sector regulation and management of environmental impacts;
    - measures to facilitate participation in international consortia for developing and evaluating technologies that may be needed for the countries of the Americas;
    - benchmarks and instruments to assess, monitor and encourage best practice standards at the firm level on a sector basis where the likely impact will be high;
    - support of the development of information technology applications for environmental education and training, and use of seminars, manuals, newsletters and electronic data bases;
    - financial promotion of technological cooperation (and upgrading environmental standards) in areas where market incentives are not adequate;
    - policies to increase investment in the intangible assets skills, know-how needed within firms for effective use and assimilation of cleaner technologies;
    - the scope for market coordination to assist both in the development of clean technologies and their utilization;
    - the role of economic instruments and performance-based measures;
    - some form of “strategic research competition”, in which member countries would provide a small number of relatively large grants to support R&D on specific environment and development problems. Rather than a capacity-building approach, this would be a peer-reviewed competition, geared to supporting path-breaking technology development, open to both public and private sector institutions and which has been used successfully in the USA;

- review of existing financial support programs for development of clean technologies and intangible technological assets, exploration of alternative financial mechanisms, including consultation with multilateral and national development banks. One key issue is how to design financial mechanisms which would be effective in reaching smaller firms, either individually or collectively;
- detailed evaluation of specific institutions providing technology information and assessment services to small firms; documentation of lessons for the design of future mechanisms;
- promotion and support of local problem-solving consortia among local firms to tackle common environment problems;

What is recommended is that the Ministers mandate the OAS to organize further background studies and further consultation in each of these areas, in order to identify feasible initiatives, to report on institutional policies and mechanisms available, and develop a strategy of action. Most international studies have a natural tendency to focus on the larger and more industrialized developing countries, paying less attention to the issues facing smaller and poorer countries. To remedy this situation, the latter should be the targets of studies.

A variety of technology support institutions have been created over the past two decades, and there is need for careful consideration of the approaches which have been more successful, and under what circumstances. Special attention should be given to the extent to which existing institutions and programs have been successful in reaching smaller, more marginalized firms.

Programmes to assist firms (either individually or via consortia) in overcoming some of the barriers towards “win-win” investments in environmental improvement, are important. It may be possible to develop an initiative focused on one or two relatively mature industrial branches, which would work to provide information, financing and human resource development to assist firms in achieving joint environmental and efficiency gains. Countries may also consider supporting some form of hemispheric initiative based on the notion of “environmentally critical technologies”.

### **Concluding remarks**

The report makes clear that environmental damage need not be an inevitable consequence of industrialization, technological advance and economic growth. New technologies already available provide a

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wide range of solutions to recognized problems, and potential future technologies hold out the prospect of even more radical solutions. Fortunately, a range of relevant technologies for reducing pollution already exist. The range of technologies available at present and others possibly available in the near term is impressive.

There is substantial evidence that in the medium term the perceived trade-off between reducing environmental damage and encouraging economic growth and development is not as rigid as is often assumed, and that the application of appropriate technologies and policies can result in increases in economic efficiency and contribute to further economic growth in all countries in the hemisphere. The attraction of building on areas of common interest is that initial actions in such areas can also help to increase the likelihood of longer-term, more comprehensive and more costly technology co-operation measures, both by demonstrating the potential for reversing current trends, and by generating the experience and confidence necessary to support longer-term and more far-reaching initiatives. □

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