Chapter VI

TECHNICAL PROGRESS, COMPETITIVENESS AND SUSTAINABLE DEVELOPMENT*

The incorporation and dissemination of technical progress helps to harmonize the objectives of international competitiveness with those of sustainable development. In Latin America and the Caribbean sustainable development has a bearing not only on the ***quality of life*** *but also, and very much more so, on the* ***standard of living*** *of the population.*

1. Introduction

International competitiveness based increasingly on the incorporation and dissemination of technical progress in a context in which great economic and political value is attached to environmentally sustainable development in many parts of the world will probably be one of the hallmarks of the 1990s. The close links between these factors, which have only recently begun to be perceived, are explored in this chapter.

In this connection, it is necessary to:

Examine the nature of the growing international competition and technical progress and their effects on sustainable development in Latin America and the Caribbean.

Consider the situation of the region in the international context in the light of its own particular natural resources and their development and the kind of entrepreneurial leadership which now exists.

Assess the relationship between international competition, technical progress and sustainable development on the basis of the link which exists between energy and changing production patterns. This link is the mainstay of that relationship, and by studying it it will be possible to compare the situation in Latin America and the Caribbean with that in the other regions of the world.

Describe trends in the market for "environment-related" technical goods and services, assessing the impact of sustainable development on the industrial sector, i.e., the way in which industry and environment interact.

2. The convergence of international competitiveness, technical progress and sustainable development

International markets are now clearly in the process of globalization and regionalization. This process has been set into motion by a notable decrease in communications and transport costs, by the ability of some nations to incorporate

* For a more detailed study of these topics, see ECLAC, *Tecnología, competitividad y sustentabilidad* (LC/L.608), January 1991. (Document prepared by the ECLAC/UNIDO Industry and Technology Division.)

technological progress and to disseminate it through their system of production, by entrepreneurship and by the incorporation of additional countries, particularly countries in South-East Asia, into the international market.

Globalization and regionalization depend on the ability to compete in international markets, an ability which is increasingly based on the capabilities of individual entrepreneurs and countries to incorporate technical progress and disseminate it through the system of production of goods and services. This is known as genuine or structural competitiveness.[1] One of its most salient characteristics is an increase in the amount of resources devoted to research and development both in the industrialized countries and in the newly industrialized countries which are now being successfully brought into the process of the globalization of markets.

In spite of this, however, it has proved impossible to exceed the growth rate of productivity recorded in the 1950s and 1960s. One possible explanation is that the emerging technological paradigm requires that enterprises, institutions and policy be so thoroughly overhauled that the effects of the new pattern will be felt only to the extent that these changes actually occur.

These new approaches to organization are aimed at enhancing flexibility in the production process and at cutting the costs of production, both of which are reflected in the quality of the goods produced –the factor on which today's competitiveness is based. The concepts of just-in-time inventory, zero defect and total quality control relate to this phenomenon; in order to use these techniques, closer links must be formed among suppliers, producers and users, something which has been made possible thanks to the rapid progress being made in the field of information technology.

In addition, the design, production, distribution and marketing processes make it possible to shorten the time required to respond to new market demands and provide the incentive for a rapid increase in the formation of alliances among enterprises of different countries and sectors.

The growing importance of design accompanied by automatization in production, distribution and marketing is rapidly eroding the comparative advantage of cheap labour. Competitiveness today is based on other factors, including the quality of the goods and services produced, the rapidity and reliability of their delivery and the capacity to diversify them as required by consumers in the industrialized countries.

The comparative advantage based on the availability of natural resources is also experiencing erosion. The effort to save energy in the industrialized countries since 1973 affects product design, manufacturing processes, transport systems and the nature of household appliances. This is the most visible effect of the phenomenon, which has many other aspects. It is in fact technological development and international competitiveness which make it possible first to develop synthetic products and introduce new materials and, secondly, to enhance efficiency in the use and saving of raw materials.

Environmental concerns play no small role in the above-mentioned trends. Sustainable development has in fact become a universally recognized value. The imperative of environmental sustainability has given rise to additional costs and also to a tremendous effort in the realm of technological innovation aimed precisely at counteracting negative effects on the environment and at increasing the ability to compete. In future the links between technical progress in the realm of protecting the environment on the one hand and international competitiveness on the other will be increasingly close.

3. Consequences for Latin America and the Caribbean

The comparative advantages of the past, which were responsible for a tremendous boom in exports, will be challenged in the next few years if certain developments occur (a decline of demand, the emergence of new competitors, the need for environmental-protection regulations or an increase in remunerations and in the tax

burden). In particular, the traditional growth strategy based on intensive use of natural resources (a strategy which was stressed in the 1980s because of the need to service the external debt) has been subject to increasing criticism since, although it does make it possible to increase the short-term growth rate, various environmental costs may be felt with even greater force in the medium term, as has, in fact, been the experience of the region in recent years (see box VI-1).

Box VI-1
PROJECTS IN PEMEX'S ECOLOGICAL PACKAGE

Petróleos Mexicanos (PEMEX) has identified eight investment projects as being strategic priority projects, whose specific purpose is to supply fuels of internationally recognized ecological quality at a cost of US$1 034 000 000, these are products aimed at reducing pollution caused by the combustion of gasoline, diesel fuel and fuel oil and at cutting down on emissions of sulfur from the Eighteenth of March Refinery. The main areas of action in PEMEX's ecological package include:

1) Gasoline. PEMEX has set itself the goal of raising the octane content of the gasolines it produces without using tetraethyl lead and adding oxygenated components to them in order to ensure fuller and more efficient combustion. To this end, the enterprise has plans to reconvert its naphtha reformers, replacing the process of semiregeneration with one of continuous regeneration in seven of its leading refineries; it also plans to install three pentane and hexane isomerizing plants and six plants producing oxygenated compounds (TAME, MTBE and methanol). The cost implications of the projects relating to gasoline production are US$413.4 million –the highest in the "package".

2) Diesel fuel. This project envisages the installation of four plants for the hydrodesulfurization of diesel oil to obtain a fuel of internationally recognized ecological standard, by reducing its sulfur content from its present range of 2% to a range of 0.10%. The project will cost US$200 million.

3) Fuel oil. Here too a product of internationally recognized ecological quality is being sought, by reducing its present sulfur content of 4% to 0.8%. This project involves the construction of a large number of plants for such processes as the hydrotreatment of waste, the generation of hydrogen, fractionation, polymerization, gas sweetening and sulfur recovery. The cost implications of the investments involved amount to US$402.9 million.

4) Sulfur recovery. This project will be carried out in the Eighteenth of March Refinery, the only PEMEX operation in the Metropolitan Area of Mexico City and calls for both the modernization of the present recovery unit and the installation of a second unit of the same type in order to give the process greater reliability. This component of the ecological package, in combination with the installation of facilities for the recovery and control of hydrocarbon vapors in supply and distribution depots, calls for a total investment of US$17.7 million.

It should be stressed that the projects in the "package", which represent a total investment of US$1 034 000 000, imply a large demand for capital goods, especially in connection with traditional products of boilermaking, equipment for heat exchange (interchangers, reboilers, coolers, heaters, condensers), pumps and compressors, reactors and distillation towers, regenerators and turbo-machinery. This demand is expected to have a positive impact on the national capital goods industry, engineering firms and employment in manufacturing.

The co-ordination of and follow-up on the action needed to give shape to the projects in the package (in a period of between 18 and 48 months) is in the hands of the unit responsible for the executive co-ordination of the ecological package; this unit is under the management of a group of associates consisting of members of the Office of the Deputy Director of Petrochemicals and of the Office of the Deputy Director of Industrial Transformation (both of which are on the second level in the company hierarchy). The task of executive co-ordination of the ecological package (third level in the hierarchy) is divided into two sections, one dealing with sulfur reduction projects and the other with gasoline improvement projects.

In general, these projects are not aimed so much at raising production capacity as at producing fuels of the same quality of fuel as those now produced, but with ecological components of the highest international standard. In spite of this, and also of the fact that it will no longer be possible to make the maximum income from domestic sales of fuels and the production of tetraethyl lead will be reduced considerably, it is estimated that the rates of return of all the projects will be positive, although the level of those rates would seem to indicate that the projects might not be embarked upon on the basis of commercial considerations alone. Thus, PEMEX is making a substantial effort which indicates its commitment to cleaning up the environment of Mexico City.

Moreover, although there is no consensus on the future scenario concerning the transfer of technology to the developing countries, there are indications of growing technological protectionism on the part of the industrialized countries.

These two developments –the erosion of the traditional competitive advantages on the one hand and the emergence of technological protectionism on the other taken in combination with a third factor of growing importance– "environmental protection" –provide the sustainable development strategy of the countries of the region with a difficult task. This situation will represent a threat to the markets for export which have already been conquered and even to potential markets unless a way can be found to move ahead fast enough in the technological field.

It is within this framework that Latin America and the Caribbean have adopted the goal of enhancing their competitiveness and raising the standard of living of their population –a goal which favours the incorporation and dissemination of technical progress in all activities relating to the production of goods and services.

Within a context of greater technological protectionism and increased demand for technology, the main ways of acquiring access to new techniques will undoubtedly be by importing equipment and signing of agreements between enterprises, which will involve some traditional or new form of direct investment. Alliances between national and international enterprises will become increasingly important as channels for the transfer of technology.

4. Technology, competitiveness and natural resources: relative position of Latin America and the Caribbean

4.1 *International insertion and natural resources*

As in the rest of the world, the economic concepts which prevailed in the region were based on the assumption that natural resources would be forever available and that the environment as a whole was all but infinite. Natural resources were regarded as a frontier to be conquered, and the insertion of the region in the international economy was based on that idea, which is directly reflected in the type of entrepreneurial leadership which characterizes the region.

In Latin America and the Caribbean, most of this entrepreneurial leadership is located in the realm of natural resources, processed or raw. As table VI-1 shows, in countries such as Argentina, Chile and Venezuela 75% or more of the 10 largest enterprises, whose sales represent close to 30% of GDP of those countries, are found in natural-resource-based sectors. In Brazil and Mexico, the two largest countries in the region, the sales of the 10 biggest enterprises amount to the equivalent of 15% of GDP, and close to 60% of those sales are concentrated in sectors associated with natural resources.

The basic difference between Latin America and certain OECD countries which are heavily endowed with natural resources is that, in those countries, industrialization is to a large extent supported by the processing of these resources. This is reflected in the capacity of such countries to develop technologies conducive to the integral use of their natural resources. This characteristic of industrialization directly favours the capacity of those countries not only to provide impetus for a new economic perspective in which technical progress, natural resources and environment are taken into account but also, and even more important, to embark on a broad spectrum of technological innovations.

During the 1980s, some of the leading enterprises in Latin America and the Caribbean learned this lesson and began to develop broad-based programmes in the field of environmental sustainability.

4.2 *Competitiveness and natural resources in the OECD market*

In addition to being the largest and fastest growing market in the world today, the market made up of the member countries of OECD also has the strictest environmental standards, and compliance with them may soon become a prerequisite for entry into the market.

Over the past decade the structure of imports of the OECD countries has been changed significantly. Natural resources, fuels and manufactures based on natural resources are showing a tendency to lose their share in the market, while manufactures not based on natural resources are showing a marked increase.

Care should be taken, however, not to underestimate the importance attributed by the OECD countries to their own domestic markets and available natural resources in defining their productive and technological paradigms in a way that is compatible with their own particular preferences and environmental needs. One important consequence of this may be the already perceptible emergence of protectionist barriers raised on the assumption that other countries have failed to comply with environmental standards relating to products, manufacturing processes and raw materials. These barriers may seriously affect some products in which natural resources play an important role. Since exports based on natural resources account for a large share in Latin America and the Caribbean, this may turn out to be a decisive issue.

It may be assumed that some of the region's exports to developed countries will remain exempt from environmental requirements, particularly in the case of exports which do not compete with domestic products (and are therefore subjected to less protectionist pressure) or exports to low-income consumers (who are not so willing to absorb cost increases stemming from environmental protection).

The important thing is that the environmental dimension has become a significant variable in any strategy relating to exports to industrial countries, in the first place because the need for environmental protection has now become a requirement which affects a large and potentially larger share of the demand of those countries and, in the second place, because environmental

Table VI-1

LATIN AMERICA: PERCENTAGE DISTRIBUTION OF THE SALES OF THE 10 LEADING ENTERPRISES IN SELECTED COUNTRIES, 1989

	Latin America	Argentina	Brazil	Mexico	Chile	Colombia	Peru	Venezuela
Total	100	100	100	100	100	100	100	100
Natural resources (not including petroleum)	13.0	5.4	13 0	...	59 6	...	44.8	14.3
Petroleum	65.9	57.9	39.3	56 3	24.8	50.8	36.5	71.5
Manufactures								
- Based on natural resources	4.9	12.4	14.6	3.5	11.9	21.2	5.1	4.5
- Not based on natural resources	11.3	5.4	18.5	26.5	...	6.0	...	1.6
- (Automotive industry)	4.4	5.4	7.2	26.5	...	6.0	...	...
- (Capital goods)	...	...	113	...	...	...	. .	...
Other sectors	4.9	19.2	14.6	13.7	3.7	22.0	13.6	8.1
Sales of 10 largest enterprises/GDP	10.7	31.4	14.6	14.7	38.2	14.9	20.9	29.5

Source: Joint ECLAC/UNIDO Industry and Technology Division, on the basis of data obtained from *América Economía*, No. 44, October 1990. The figures relating to GDP were taken from World Bank, *Development Indicators*, vol. IX, No. 37, 26 September 1990.

requirements differ enormously from country to country and are frequently changed; so it is becoming necessary to keep an eye on them in order to ensure permanent access to the OECD market; and finally because the growing value which society attaches to environmental requirements, even when the importing country does not explicitly insist on them, means that they can be turned into an instrument for differentiating between products, which is a particularly useful device in markets with relatively steady demand.

It is also true that the requirements imposed by developed countries do not eliminate the environmental problem caused by externalities linked to the production process (e.g., air or water pollution at the production site). Some transnational corporations have moved to developing countries in order to avoid the costs relating to environmental regulations in developed countries although the goods they produce may be in compliance with environmental requirements of the importing countries. When this happens, the developed countries are "exporting their environment" with diverse consequences. However, although the production processes used by firms which have relocated may not meet the requirements of their home country, they sometimes damage the environment less than the processes used by national enterprises. In such cases, the net result of the relocation may even be positive for the environment of the recipient country It is still necessary, however, to monitor these relocation processes very closely.

5. Technology, competitiveness and environmental sustainability: The energy system

Perhaps the clearest indication of the links between technological change, competitiveness and sustainability is provided by the changes experienced by the energy/production system. The technological pattern which has been emerging since the 1970s includes –among other factors which make it different from the pattern which preceded it– high-cost energy and requirements relating to environmental sustainability. In order to adapt to the new conditions, it was necessary to introduce technical changes in the energy/production system with a view to meeting the new, stricter requirements in the areas of international competitiveness and environmental sustainability. The industrialized countries led the way in this effort to overhaul production patterns, while in the Latin American and Caribbean region inertia against it was again manifested at the level of production and technology. The region cannot postpone the task of catching up in those areas in the 1990s.

5.1 *The energy crisis and changing production patterns*

In recent decades the world energy system has been profoundly affected by the oil shocks of 1973 and 1979 (the effects of the crisis in the Gulf are still not known) and the slowdown in the growth of the world economy.

Up until the first oil crisis, an increase in the consumption of energy was regarded as an essential requirement for economic growth, and it was felt that the use of energy produced on a large scale would increase as economies became more sophisticated.

The slowdown in energy consumption as the OECD countries' pattern of production changes is the result, first of all, of an attempt to make their economies less vulnerable. Secondly, it is caused by the need to cope with more intense competition in the realm of international trade and finally it comes in response to a wish to increase environmental sustainability. In order to meet that goal, the OECD countries introduced energy-efficient technologies, diversified their sources of energy supply and made their energy system more flexible.

Thus, since the 1970s, energy intensity (the ratio between the final consumption of energy and GDP) has been experiencing a significant decline in the industrialized countries not only because of the introduction of technological changes but also due to the moderate growth rates of energy-intensive industries (steel, heavy industry in the chemical sector, non-ferrous metallurgy,

Table VI-2
SELECTED OECD COUNTRIES AND LATIN AMERICA: ENERGY-INTENSITY TRENDS

Indicators	Years	Countries				
		United States	Japan	France	Fed.Rep. of Germany	Latin America
Energy intensity	1970	142	151	137	125	102
in terms of GDP	1973	156	163	138	124	100
(1985=100)	1981	121	112	105	103	97
	1986	97	99	98	103	98
	1987	96	97	98	99	100
Energy intensity in	1970	168	193	210	157	84
terms of industrial	1973	168	190	165	147	77
production	1981	133	119	115	112	89
(1985=100)	1986	94	93	95	95	94
	1987	96	91	93	92	101

Source: Joint ECLAC/UNIDO Industry and Technology Division. Data for Latin America was compiled on the basis of information obtained from OLADE.

cement, etc.) in contrast with the dramatic expansion of technology-intensive industries.

Although the methodology of separating the impact of energy saving technologies from the impact of structural change is difficult, it is estimated that technological innovation accounts for between 66% and 75% of the drop in energy intensity. Table VI-2 summarizes the overall energy-intensity trends in some OECD countries and in Latin America.

These figures reflect the results of policies implemented by OECD countries to promote the efficient use of energy and natural resources. The energy-intensity indexes for Latin America show no change whatsoever at the level of the economy as a whole but do denote an increase in the energy intensity of industry.

5.2 *Energy and its effects on the environment*

Medium- and long-term environmental problems of universal concern include several which are directly related to energy use. Some of these have an impact at national or international level, as is the case of the greenhouse effect, the destruction of the ozone layer, deforestation and desertification, acid rain and the disposal of nuclear waste.

In addition to the problems just mentioned, there are others of a more local but equally important nature, including population migration; flooding of croplands and climatic changes caused by large hydroelectric power plants; the exploitation of mineral deposits in a way which causes soil deterioration, water pollution and hydrogeological alterations; and nuclear accidents, pipeline explosions and oil spills at sea (see box VI-2).

Supplying energy to areas where it is in short supply or of unsatisfactory quality makes it possible to make progress in such areas as the creation of new productive activities, the improvement of the productivity of existing activities and the introduction of changes in the structure of employment and the distribution of income. Properly conceived hydroelectric power projects make it possible to recover deteriorated

Box VI-2
THE ENVIRONMENTAL ACTIVITIES OF PETROLEOS DE VENEZUELA, S.A.

As has happened in the case of other oil companies, environmental concerns have only recently begun to be taken into account in conducting the routine activities of Petróleos de Venezuela, S.A. (PDVSA). Environmental activities have, however, become increasingly important as is shown, for example, by the creation of an office for environmental management in the parent company and in each of its subsidiaries, a committee on environmental affairs which operates between subsidiaries to co-ordinate their activities and, finally, an ecological and environmental research office within the Venezuelan Technological Institute of Petroleum (INTEVEP), the PDVSA subsidiary for research and development. PDVSA plans to invest close to US$142 million in environmental affairs in 1991.

PDVSA activities in connection with the environment are centred around two major concerns –first, production processes and their impact on the environment and second, products and their conformity to the prevailing standards and specifications in domestic and external markets.

Oversight and improvement of production processes

The company's early environmental efforts with regard to its production processes related to the growing awareness in Venezuela of the danger of exhausting its petroleum resources. As soon as this danger began to be felt, programmes designed to save oil resources at national level and to conduct an intensive search for additional energy sources or energy alternatives began to be devised. In this connection, mention should be made of the efforts to explore the Orinoco bituminous belt and the attempts to replace oil by gas in domestic consumption. The considerable energy resources discovered in the Orinoco region were responsible for increasing PDVSA's concern for the environment, since the deposits found contained primarily extra-heavy crudes with a high percentage sulfur (2%-4%), nickel and vanadium and therefore could not be refined in conventional plants and increase the danger to the environment.

More recently, the bulk of the company's efforts were directed towards minimizing the environmental impact of its production processes, with special emphasis placed on the adoption of preventive measures. These efforts took the form of environmental impact assessments and periodic inspections aimed at minimizing the impact of the petroleum sector on the environment. The first environmental impact assessment concerned was carried out in 1979 for the purpose of analysing the possible effects of developing the petroleum resources in the Orinoco area, a region which at that time, in spite of the fact that its remote geographical location made access to it difficult, was already regarded as Venezuela's main source of energy for the near future. Environmental impact assessments similar to the one referred to have become common since then, and the company has made them requisite to any new or expanded project. Since 1979 PDVSA has conducted 30 studies of this kind.

In 1986 the company strengthened its preventive maintenance programmes by introducing routine environmental inspections for the purpose of ensuring compliance with periodically updated standards of security, in the hope of reducing the risk of accidents. The main objective is to prevent spills of toxic products by carrying out regular technical inspections, installing protection systems and replacing and repairing equipment in time. A special effort has been made to limit the danger of spills caused by corrosion by implementing a programme for the specific purpose of cleaning and replacing used tanks in the national system for hydrocarbon distribution and storage.

Another form of preventive action concerns the introduction of new, demonstrably cleaner, technologies in the production processes. One of the most promising programmes in this respect is that for the incorporation in petrochemical plants of new technologies which will make it possible to eliminate the use of mercury in the production of sodium hydroxide. New processing techniques have been introduced in the leading refineries with a view to reducing harmful atmospheric emissions. This includes, in particular, the installation of gas desulfurizing plants in all refineries. The contribution made by INTEVEP to the design of these new technologies has been significant, particularly in the creation of new catalyzers for the demetalization of crudes and the reduction of the levels of nickel and vanadium in the corresponding waste.

river basins, to divert water resources for use as drinking water and/or the irrigation of croplands and to reduce desertification and erosion

Unless the proper precautions are taken, however, the construction of hydroelectric dams will affect both the biophysical and the social

environment involved; the use of energy in urban transport or of fossil fuels in industry will cause pollution whose intensity will depend on the technology used, the quality of the fuels consumed and the degree of maintenance of the equipment; defects in the thermal quality of dwellings and in cooking and heating appliances will seriously affect the quality of life and the health of large sectors of the population (see box VI-3). As for transport, inefficient or poorly designed transport systems will pollute the environment, especially in metropolitan areas.

Box VI-3
ENVIRONMENTAL IMPACT OF DIFFERENT ENERGY SOURCES

Although this schematic presentation has certain limitations as to the scope and relative importance of the environmental impact had by various energy sources, it nevertheless provides an overall view of the close links which exist between energy and the environment and draws attention to the different effects of the various sources at different stages in their exploitation, from extraction of the energy resource to disposal of the waste produced.

Brief comments are made below concerning the more far-reaching of those effects. The first sector considered is the coal industry, since coal seems to be the energy source which has the most adverse impact on the environment.

– Resource extraction

The exploitation of opencast coal mines alters the topography of their sites and deteriorates the land under exploitation.

Underground mines weaken the surface ground, causing problems in connection with roads, bridges and other structures built above the mines.

Mining generates waste, which must be deposited on nearby land so that it cannot be used for farming.

– Resource processing

The pulverization of coal generates a large number of particles, which increases the danger of fires and explosions. The gasification of coal pollutes waste water through the condensation of the tars produced.

Electric power generation

The combustion of coal produces flying particles and acid rain and contributes more than the burning of any other fuel to worsening the greenhouse effect.

– Waste disposal

The ashes produced by the combustion of coal become flying particles. Coal ash must be deposited on extensive sites, and this may limit the possibility of putting them to agricultural use.

As for petroleum, its most adverse impact relates to acid rain, which results from electric power generation. However, recent accidents during transportation, loading and unloading make it recommendable to place greater stress on the adverse effects which petroleum may have.

As for nuclear energy, it seems to be among those energy sources which cause least damage to the environment. The as yet unresolved problems of radioactive waste, accidents in nuclear power plants and the possible proliferation of nuclear weapons cannot, however, be ignored.

As for the generation of solar electric power, it must be noted that when this is done on a large scale, vast tracts of land are required for the installation of the necessary photovoltaic cells or solar collectors. This limits the possibility of using such land for farming.

As for ethanol and methanol, the following effects may be noted:

– Raw material extraction

Because the raw material needed to produce these alcohols is obtained from crops planted specifically for that purpose, the problems typical of any monoculture arise. The possibility of obtaining high yields from these crops depends on the use of fertilizers, weed killers and fungicides, normally composed of chemicals, with the consequent environmental effects.

– Raw material processing

Accidental methanol leaks may damage the sight or respiratory systems of refinery workers.

Finally, it should be noted that reference is made here only to the generation of electricity, with no mention made of the part played by its use, which contributes significantly to environmental deterioration. By the same token, it should also be noted that the possible adverse effects of large hydroelectric power stations have not been touched upon.

The industrialized world has led the way in the search for solutions to these problems, some of the solutions found are short-term solutions, while others apply to the longer term. Short-term solutions

include: i) restricting emissions of CO_2, SO_2, and NO_x, ii) stressing the development of equipment designed to control "down-stream" emissions and iii) promoting the use of nuclear energy on grounds that it does not emit the kind of toxic oxides or gases which produce the greenhouse effect. Of the longer-term solutions, mention may be made of: i) international agreements on reduction of emissions; ii) the financing of research on as yet insufficiently defined problems, such as those related to the greenhouse effect; iii) the establishment of standards and regulations on levels of emissions and efficiency of equipment; iv) the development of sources which cause less pollution; and v) the initiation of energy conservation programmes.

In the context of Latin America, consideration should be given to those options which best respond to regional requirements, with thought being given to the availability of natural, technical and financial resources and to the need to achieve a sustainable form of development.

It is therefore of vital importance to make an effort to increase, on a permanent basis, the efficiency of energy use, for reasons both of international competitiveness and of sustainable development. Atmospheric pollution (sulphur and nitrogen oxides and carbon dioxide) varies almost proportionately with the energy intensity of any given activity. For each petroleum equivalent ton of fuel (PET) 2.4 to 4.5 tons of carbon dioxide (CO_2) are emitted. It takes one hectare of woodland to absorb the CO_2 produced by burning one ton of coal.

International experience shows that a powerful tool for obtaining lasting results from energy conservation and environmental protection programmes is the establishment of standards and regulations for users and suppliers (manufacturers of equipment, housing designers and builders, boilers and kiln operators, etc.).[2]

5.3 *Energy and sustainable development in Latin America and the Caribbean*

During the 1970s and part of the 1980s, Latin America and the Caribbean carried out large-scale projects in the energy sector, particularly with regard to the generation of electricity. The sector absorbed a high percentage –in some cases, over 50%– of the public investment of the countries of the region. According to the same source, the external debt of the sector amounts to close to US$80 billion, 60% of which corresponds to the electricity subsector.[3]

Since the growth forecast for the coming years will call for annual investments of between US$15 billion and US$20 billion, a difficult future for the region may be predicted. These difficulties are compounded by widespread financial deterioration of service enterprises owing to the recessive economic climate and the gap between public service rates and real costs, high losses of electricity, mismanagement and, in some cases, weaknesses in infrastructure and maintenance programmes.

In addition it must be noted that the alternatives consistent with sustainability are not always in accordance with the priorities of development financing agencies. Thus, between 1972 and 1990, more than 90% of energy financing from multilateral and bilateral development agencies was earmarked for large-scale projects, whereas only 1% was allocated to energy conservation projects.

Consequently, from the energy perspective, sustainable development calls for the adoption of the following measures in Latin America and the Caribbean:

i) formulation of an energy planning strategy from the standpoint of end use;

ii) implementation of a resolute, enterprising energy conservation policy;

iii) provision of energy to low-income sectors;

iv) adoption of energy options which minimize negative environmental impacts by maximizing the use of the least polluting renewable energy sources and fossil fuels;

v) in countries which must develop their energy sources on the basis of local resources whose exploitation damages the environment,

such as coal and biomass, incorporation of technologies which keep their impact down to a minimum;

vi) solving of the problem of financing the sector;

vii) improvement of the management of service enterprises;

viii) strengthening of regional energy institutions; and

ix) laying of the foundations for the development of extensive regional and international co-operation in the sector.

As these measures suggest, an energy sector with enough sustainability to meet the development requirements of Latin America and the Caribbean can be achieved only by significantly reducing that sector's external vulnerability, considerably increasing the efficiency of energy production and use, helping to eliminate environmental degradation and minimizing any adverse environmental impact which might be caused by the region's energy system.

In view of the responsibility the industrialized countries bear for the deterioration of the environment down through history and the fact that it is impossible for the developing countries to tackle the energy and environmental problem in isolation, the industrialized countries should assume a large share of this task.

The countries of the region in conjunction with more highly developed countries and with support from international financial agencies should establish machinery for transferring their positive experiences in these fields, providing the technology, capital and manpower needed to ensure the massive dissemination of technologies which promote efficient use of energy and the application of renewable energies. The establishment of information centres on appropriate technologies for this purpose would be a highly positive step in this direction.[4]

International co-operation designed to meet these objectives will contribute more effectively to world environmental sustainability than the enforcement of carbonic acid gas quotas and/or restrictions on the exploitation of resources. It is also better than policies designed to promote intensive exploitation of natural resources in order to meet external debt commitments in the short term.

6. Industrialization, enterprises and environmental sustainability

6.1 *Industrialization and sustainable development*

In the developed countries it has become generally accepted that industrialization is an important factor in environmental deterioration. In Latin America and the Caribbean, with the usual differences from country to country and with omissions and variations, industrialization followed the same lines as in the developed countries. During the next decade it is expected to provide the key to changing production patterns, primarily because it is responsible for the incorporation and dissemination of technical progress but also because, in the new circumstances of the decade, it will be necessary for industrialization to go beyond the narrow sectoral margins within which it has been confined and form links with areas concerned with the exploitation of primary commodities and with services in order to integrate the production system and promote the gradual homogenization of the levels of productivity within it. Breaking away from sectoral boundaries is one of the keys to changing production patterns and to the new phase of industrialization.[5] In terms of environmental awareness, the region lags behind the developed countries. If it wishes to raise the standard of living of its population, however, it is vital for it to continue to promote industrialization in accordance with the new guidelines set, incorporating the experience of the industrialized countries in their efforts to co-ordinate growth, competitiveness and environmental sustainability.

In Latin America it may be observed that the sectors with the greatest environmental impact in the 1980s (consisting primarily in capital- and natural-resource-intensive industries which produce intermediate products, such as the

petrochemical, paper and cellulose, metallurgy and iron and steel industries, petroleum refineries and tanneries) have increased their share in regional production, world production and exports to the OECD countries. During the same period, the share of these commodities in production in the developed countries decreased. If this trend continues without incorporating the technology needed to reduce or eliminate the adverse impact of these activities on the environment, localized situations of severe environmental deterioration similar to those found in developed countries may occur in the region.

In the developed countries it may be noted that, in the few cases for which systematic data exist,[6] technology designed to correct end-of-the-line environmental damage still predominates. The so-called "clean technologies" (for which no strict definition exists), which are based on innovations in equipment or processes designed to deal with environmental damage before the end of the production process, attract about 20% of the total environmental investment (as opposed to 80% for end-of-the-line technology). This percentage is considerably higher in certain sectors such as those engaged in the production of paper and paper products, chemicals, petroleum and transport equipment. The adoption of "clean technologies" would help to save on energy and raw materials, reduce waste, improve the quality of the goods produced, raise productivity and shorten the idle time and reduce the health hazards of workers. For all these reasons, it may be seen that the time it takes to recover investment is short. Nevertheless, the rate of dissemination of "clean technologies" is low even in the developed countries, which is usually attributed to problems of access to technological information and financing and to the peculiarities of the prevailing environmental regulations. They will probably begin to be used more widely in the next few years, however.

In the case of Latin America and the Caribbean, whose industry is in the process of change owing to the opening up of the economy, it is essential to design and implement a strategy aimed at the widespread introduction of "clean technologies" while profiting from the experience acquired in their countries of origin with regard to overcoming the obstacles to their dissemination. Special attention should be drawn to the importance of transferring these technologies from large enterprises to medium-sized and small firms for which market incentives may not be enough. We should not underestimate the magnitude of the efforts related to technological adaptation and innovation required before technologies already invented and available in industrialized countries can be used effectively.

The design of the strategy mentioned above calls for much research into the environmental effort now under way in areas relating to production in Latin America and the Caribbean, at the level of sectors, enterprises and legislation and with regard to the kind of incentives and resources which might be used to bring about behaviour in line with the objective sought on the part of the various protagonists (large public enterprises, national and foreign; small and medium-sized undertakings; regulatory agencies; engineering firms; lending institutions; training centres; institutions providing technological support and the mass communications media). The composite findings obtained, supplemented by information concerning institutions and enterprises in the developed countries which would be willing to co-operate could lead to realistic and effective programmes whose support and strength would come from resources available both in the region and in the developed countries (see chapter X).

6.2 *The organization of production and sustainable development: Trends*

At first, measures aimed at environmental conservation consisted of end-of-the-line treatment of industrial emissions and in sending waste products to landfills. Enterprises encountered few restrictions on the disposal of the waste they produced, but with the passage of time, serious problems arose as to its elimination.

In densely populated regions, the volume of solid waste of industrial and domestic origin has risen concomitantly with the growth of

population and consumption, the result being a space problem in connection with the final destination of the waste produced. In addition, it has been shown that rubbish dumps constitute an additional source of pollution since they affect groundwater, soil and air quality in their vicinity and hence the welfare of the people (usually poor people) who live nearby.

In addition, some industrial waste is toxic and must be treated or put into special containers prior to its final disposal; and the cost of such end-of-the-line treatment has risen considerably.

The most common way of dealing with these problems is by means of technological innovation. Production processes are modified in order to reduce the production of waste as much as possible and also to change its composition, making it a less potent source of pollution. This is the "clean technologies" approach. Some of the more traditional forms it takes include making use of certain waste products which have completed their life cycle, the recirculation of by-products and waste water within industrial plants and the recycling of durable containers and recovery of used paper.

A growing number of industrial enterprises, particularly large enterprises, have set up units at various organizational levels which are responsible for dealing with environmental questions. Enterprises are also beginning to incorporate the environmental component systematically into their strategies and operational procedures. In addition, they try to shape the attitudes of their staff through technical training programmes. In some cases, the concern of enterprises for the environment even extends into the local community in their vicinity, for the prevention of any kind of hazard, including health hazards. When this happens, enterprises act as centres in which people learn how to meet the environmental challenges of the coming decades.

An appropriate technological solution to some pollution problems has not yet been found, for reasons of cost or effectiveness or for other reasons. The determination shown by the authorities of some countries to deal with these problems has, however, done much to stimulate a high degree of development and technological innovation. In this connection, small- and medium-sized firms are playing a leading role in the development of new environmental technologies and in their commercial application.

6.3 *The market for goods and services for environmental protection*

Within the scenario described above, a new "environment-related" goods and services market is springing up. Most of the products available in it are not new; it consists rather of certain goods and services which have been regrouped to meet stricter legal requirements and a growing demand based on environmental conservation objectives. This market also offers enterprises and entrepreneurs opportunities to diversify and to set up new lines of business. The goods and services used to protect the environment make up a vast range of products as diverse as attempts made by enterprises to solve their pollution problems.

Much of the growth of the demand for goods and services to protect the environment has been spurred by the application of environmental legislation in the form of programmes, regulations and standards. The promulgation of each special law or regulation gives rise to a new wave of demand for certain goods and services of this type, which later stabilizes. Although waves of demand for industrial goods and services may overlap in time, they are not synchronized. Consequently, the aggregate demand for environment-related goods and services also shows rather wide annual fluctuations.

Industrial statistics and censuses only partially cover the costs of purchasing these products because enterprises find it difficult to separate these categories, which frequently include other items. It can, however, be noted that according to figures provided by the Environmental Protection Agency (EPA) of the United States of America, in 1985 the total cost of environmental protection as a share of GDP were as follows: United States, 1.7%; Federal Republic of Germany, 1.5%; Netherlands, 1.3%; United Kingdom, 1.3%; France, 0.9% and Norway, 0.8%. The trends and projections established for the United States of America and Western Europe show an increase in

the share of the cost of environmental protection in GDP.

A very good indication of the boom in this market is the number of international fairs specializing in environment-related products. In this connection mention can be made of the International Trade Fair for Waste Disposal (IFAT), held at Munich, Germany, every three years; the International Trade Fair and Congress for Engineering in Environmental Protection (ENVITEC) in Düsseldorf, Germany, which is also held at intervals of several years, and the Environmental Tech Expo (ETE), to be held at Chicago in April 1991. The German fairs, which have been operating for a number of years, both attract a growing number of exhibitors and visitors. The Environmental Tech Expo in Chicago will be the first fair held in the United States of America in which the whole range of environmental technologies are exhibited. A number of exhibits specializing in various environmental topics are also held in the United States.

The market for goods and services to protect the environment does not set up high barriers against the entry of new competitors. This is illustrated by the fact that in the Federal Republic of Germany, this segment of the market included close to a thousand suppliers at the beginning of the 1980s, and their number has now grown to over four thousand.

A large number of the enterprises specializing in the supply of environment-related goods and services are small- and medium-sized undertakings since environmental protection projects usually call for specific solutions, which gives small- and medium-sized suppliers certain advantages due to their flexibility and capacity for innovation. Recently, however, this market has experienced some penetration by large enterprises, whose strategies consist in the diversification of their production programme, the creation of subsidiaries, the acquisition of specialized firms and the formation of joint ventures.

Suppliers who are able to provide integral solutions along with their production technologies and have not specialized in only one environmental area have the competitive advantages in this market. In addition, large enterprises have a greater financial capacity than small firms. In some cases, small enterprises have reacted by seeking forms of co-operation in the task of adapting to changing market conditions.

6.4 *The market for goods and services for environmental protection in Latin America and the Caribbean*

The demand for goods and services used for environmental protection in Latin America and the Caribbean is not the same as in the developed countries. The countries of Latin America and the Caribbean are more concerned about sustainable development than about environmental protection as such.

Insufficient attention was paid to infrastructure projects relating to environmental protection and basic sanitation during the past decade because of economic stagnation. Since, in addition, the debt crisis made it necessary to gain foreign exchange, export efforts were usually concentrated on sectors associated with the exploitation of natural resources. This combination of circumstances put heavier pressure on the environment.

In order to learn about the activities and programmes carried out by large Latin American enterprises to promote conservation of the environment and sustainable development, a questionnaire was sent to a number of such enterprises in October and November 1990. Its findings revealed, *inter alia*, what investment efforts the enterprises were engaged in in various fields. The sample was made up of industrial firms in Brazil, Chile, Mexico and Venezuela which exploit or process natural resources and are engaged in activities relating to petroleum, mining, metallurgy, iron and steel, cement, cellulose and paper, foodstuffs, electric power generation and, in one case, tourism. The enterprises in respect of which information was obtained are identified in table VI-3.

The replies to the questionnaire and other information collected indicate, in general terms, that all expanded and newly built (in the past five to 10 years) industrial plants as well as all plants projected for the immediate future are provided with environmental protection facilities and

Table VI-3

LATIN AMERICA: GENERAL DATA ON SELECTED LARGE LATIN AMERICAN ENTERPRISES, 1989

Country	Enterprise	Ranking [a]	Sales (millions of dollars)	Employees (number)	Sector	Ownership [b]
Brazil						
	PETROBRAS & DISTRIBUIDORA	3	11 571.0	60 126	Petroleum	S
	CIA. VALLE DO RIO DOCE	34	2 072.2	23 415	Mining	S
	NESTLE Brasil	43	1 766.8	10 338	Foodstuffs	F
	ELECTROSUL	166	565.4	4 439	Electricity	S
	ARACRUZ CELULOSE	268	356.7	4 750	Cellulose/paper	P
Chile						
	CODELCO	8	4 029.9	27 303	Mining	S
	ENAMI	116	742.4	2 986	Mining	S
	CIA.PAPELES Y CARTONES (CMPC)	232	420.7	36 762	Cellulose/paper	P
	CIA.DISPUTADA DE LAS CONDES	310	310.8	1 500	Mining	F
	NESTLE CHILE		350.0	3 500	Foodstuffs	F
Mexico						
	PEMEX	1	15 073.9	...	Petroleum	S
	NESTLE MEXICO	132	670.6	5 800	Foodstuffs	F
	CEMENTOS TOLTECA (PLANTA ATONILCA)	180.0	710		Cement	P
	SIDEK DIVISION SIDERURGICA				Iron and steel	P
	SIDEK DIVISION TURISTICA		250.0	5 000	Tourism	P
Venezuela						
	PDVSA	2	12 483.7	45 069	Petroleum	S
	CVG	23	2492.8	35 539	Mining	S

Source: Joint ECLAC/UNIDO Industry and Technology Division, on the basis of information taken from *América Economía*, No. 44, October 1990, and information supplied by enterprises.

[a] Construed on the basis of information concerning the annual sales of the 500 largest enterprises in Latin America as of 31 December 1989.

[b] S: State P: Private (local) F: Foreign private.

incorporate "clean" technologies in accordance with modern technical standards. In cases where it was possible to compare the investment in environmental protection with total investment in the projects concerned, the figures obtained show that new Latin American plants meet international standards. These data support the estimates made concerning the potential demand for goods and services used in environmental protection in Latin America and the Caribbean, at least in so far as the production sector's component of that demand is concerned. In estimating that demand, it must be borne in mind that investment in environmental protection is heavier in industrial activities related to the exploitation and processing of natural resources.

The present investment in goods and services relating to environmental protection in Latin America, estimated on the basis of information provided by manufacturers of equipment and the leading user firms in selected countries of the region (Brazil, Mexico, Chile and Venezuela) amounts to close to US$2 billion.

In view of the prospects that Latin America will recover its growth in the 1990s, which would be accompanied by a rise in the investment coefficient, and in consideration of the need to progress gradually towards sustainable development, it may be concluded that the regional demand for "environment-related equipment" will expand at an estimated rate of not less than 10% a year on average in the coming decade –a rate which is comparable to that recorded in the developed countries in the 1980s.

As for the findings of the survey on supply conducted in some countries of the region, they indicate that in those countries which are most advanced in terms of industry, local supply can meet much of the market demand, both qualitatively and quantitatively. There are two exceptions to this general rule –one in the category corresponding to measuring instruments and automatic equipment, which are to a large extent imported. The other exception relates to the mechanical, electric and electronic components of equipment. Local supply of such components has not kept pace with the finished products, sometimes because of the limited size of the local market or because of existing relations with specialized suppliers abroad.

6.5 *Entrepreneurial strategies for sustainable development*

By comparing the findings of the questionnaire designed for a number of large Latin American enterprises with the criteria used by the United Nations in respect of sustainable development [7] some idea can be formed of the progress shown by Latin American management in this respect.

The subjects covered by the questionnaire included technological research and development and investment programmes related to protection of the environment and their impact on production costs and on competitiveness, measures adopted with regard to organization, and, finally, the purposes for which these various programmes and measures were established.

An analysis of the data obtained shows that in spite of the difficulties they experienced during the 1980s, large Latin American enterprises have established effective policies in the realm of environmental protection. It may also be seen that the majority of the enterprises surveyed are determined to expand these policies with a view to the gradual incorporation of concepts of sustainable development (see box VI-4).

The data obtained also show that in addition to the progress they experienced in the field of environmental protection, the companies surveyed also encountered some difficulties in various areas. In the area of research and development, the effort made by enterprises to develop new processes and products would seem to be insufficient. The oil companies constitute an exception to this observation, particularly with regard to the development of new refining processes for the manufacture of ultra-refined benzines, clean fuels and additives. An important incentive in this case is the prospect of being able to place these products on export markets.

A number of limiting factors may also be observed in connection with investment in environmental protection. Old factories do not always have the facilities they need to protect the environment to the degree required. Some public

Box VI-4

CORPORACION VENEZOLANA DE GUAYANA AND ENVIRONMENTAL PROTECTION

The Venezuelan Corporation for the Guayana Region (CVG) was established for the purpose of encouraging and co-ordinating the economic and social development of the Guayana region, integrating it with the country as a whole, in accordance with the general orientation of the National Plan. In order to achieve this objective, the CVG gave priority to industrial development in the region, creating and promoting a series of basic industries that are at present operating under its control.

CVG is made up of the following firms:

CVG Ferrominera del Orinoco C.A., iron ore processor;

CVG Venezolana de Ferrosilicio C.A. (FESILVEN), ferrosilicon producer;

Interamericana de Aluminio C.A. (INTERALUMINA), Aluminios del Caroní S.A. (ALCASA) and Industria Venezolana de Aluminio C.A. (VENALUM), producers of aluminium;

CVG Compañía General de Minería de Venezuela, engaged in the exploitation of gold-bearing deposits, and

Electrificación del Caroní (EDELCA).

The corporation also has investments in another group of firms that are related to mining and metallurgical activities and are established both within the country and abroad.

In subsidiary firms of CVG, and likewise in some of the enterprises associated with it, environmental control units have been organized. The units of the first group together are composed of 48 persons (nine technicians and 39 professionals), whereas those of the second group work with a total of 25 persons, mainly technicians and manual workers, under the direction of a professional. In brief, 73 persons (including 40 professionals and 18 technicians) are involved in environmental control work.

These operative units have an environmental pollution control laboratory and equipment valued at US$1 million.

The different industries affiliated with CVG are using similar methods for measuring the impact of their activities on the air, water and soils. In addition, they are organizing environmental education campaigns within and outside the industrial plants and are carrying out programmes in the area of industrial hygiene (evaluation of the level of noise, gases, dust, heat, illumination, radioactivity, basic hygiene and ergonomics).

The firms associated with CVG are also carrying out programmes designed to control specific environmental problems they are facing, primarily those related to air and water pollution and the handling of solid waste.

In the industrial zone of Matanzas, sizeable investments have been made in equipment for controlling environmental contamination. The following figures give an idea of the magnitude of these efforts:

— Investment in equipment for air pollution control: US$32 million.

— Investment in equipment for water pollution control: US$1 million.

— Annual cost of operation and maintenance of pollution control equipment: US$2 million.

At the regional level various initiatives have been undertaken for confronting environmental problems. The following may be mentioned as examples:

— The National Experimental University of the Guayana Region, in co-ordination with the main CVG firms, plans to offer post-graduate studies in environmental sciences.

— In conjunction with the Ministry of the Environment and Renewable Natural Resources (MARNR), CVG has been making plans for the installation of an early warning network for air and water quality in industrial areas.

— The main CVG firms, MARNR and other official and private institutions have held four regional seminars on environmental conservation.

— In order to comply with existing legal regulations, CVG has also been working on a project designed for short-term actions on problems related to the management and elimination of toxic and dangerous waste.

In 1990, the corporation created a new department, the Office of the Vice-President of Environment, Science and Technology, whose purpose is to enforce, on behalf of MARNR, national land management policies and to defend, improve and conserve the environment in the Guayana developing region. It is also responsible for encouraging, systematizing, harmonizing and consolidating the scientific and technological work of the corporation and its firms.

enterprises in countries with financial difficulties are periodically subjected to cutbacks in their investment budgets. Works for the protection of the environment, in particular, are frequently the objects of decisions to postpone or suspend their projects. Finally, it seems that insufficient attention is still being paid to changing production processes as an alternative to end-of-the-line treatment of emissions and waste.

In the area of organizational measures, it may be observed that enterprises are still making little use of environmental auditing from outside. At the same time, access by public and private entities to environmental information available in the enterprises is still limited in some respects. Enterprises still seem unclear as to their assessment of the impact of environmental protection measures on production costs and competitiveness. They only note that measures adopted to protect the environment have in general had a positive effect on their public image. As for the reasons why enterprises have established environmental protection programmes, the replies sometimes reflect a defensive attitude. To some extent, enterprises still wait for governmental intervention or local community action before adopting corrective measures in respect of environmental problems. The nature and effectiveness of these actions depends on the existing decision-making (institutional capital) systems and community participation in such decision-making, a subject to be dealt with in the following chapter (chapter VII).

A set of proposals for solving the problems noted in this chapter may be found in chapter X.

Notes

[1] See ECLAC, *Changing Production Patterns with Social Equity, op. cit.*

[2] Thus, for example, the response of the Government of the United States of America to the oil crisis consists of four policies aimed at: diversification of energy sources, promotion of oil exploration in its own territory, establishment of oil reserves in case of another crisis and energy conservation. Of the four, the one which lasted the longest and had the strongest economic impact was the last one named. In France, on the other hand, a number of regulations and ceilings have been in effect since 1974 with regard both to the thermal characteristics of buildings and dwellings on the one hand and energy consumption by vehicles and the operation of industrial equipment, on the other.

[3] OLADE, *La deuda externa del sector energético de América Latina y el Caribe*, Quito, 1988.

[4] See International Environmental Technology Transfer Advisory Board (IETTA), *Draft Final Report*, Washington, D.C., 10 December 1990.

[5] See ECLAC, *Changing production patterns with social equity, op. cit.*

[6] See UNIDO, *Industry and Development: Global Report 1990/91*, chapter III, 1990.

[7] United Nations, Economic and Social Council, "Transnational corporations and issues relating to the environment: Report of the Secretary-General" (E/C.10/1990/10), 28 March 1990.