



GOVERNMENT
STRATEGIES
AND POLICIES
FOR CLEANER
PRODUCTION

United Nations Environment Programme
Industry and Environment



UNEP

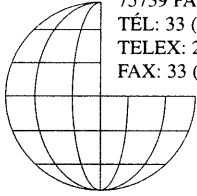


Cleaner Production Programme



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First edition 1994

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UNITED NATIONS PUBLICATION
Sales No.
ISBN

INTRODUCTION

The idea of publishing a guidance and information document on the strategies and policies that governments can use to stimulate cleaner production in developing countries and economies in transition emerged at a joint workshop sponsored by the United Nations Environment Programme Industry and Environment Centre (UNEP/IE) and the Organization for Economic Cooperation and Development (OECD) in Paris, 7–8 June 1993. A list of those who attended the workshop is given in the Appendix.

Although informed by the discussions at the workshop, this document is not a workshop report, but rather a further development of the ideas discussed there.

The purpose of this report is

- ❖ to explain to leaders in government and industry that cleaner production is likely to lead to economic benefits as well as environmental ones, that there is now an important window of opportunity that should be seized, and that cleaner production is the best way of fulfilling the requirements of Agenda 21;
- ❖ to emphasize the importance of developing strategies and policies to implement cleaner production;
- ❖ to spell out an effective overall strategy in beginning a cleaner production programme; and
- ❖ to describe some of the instruments that are available to governments for implementing cleaner production policies.

Cleaner production is an evolving concept, and experience of strategies and policies that have helped promote cleaner production is limited. As more experience is accumulated, UNEP will revise and expand this publication to outline effective strategies for initiating cleaner production programmes. In this respect, UNEP welcomes all comments and suggestions.



UNEP



Cleaner Production Programme

The authors

Nicholas Askounes Ashford, Professor of Technology and Policy at the Massachusetts Institute of Technology, United States, prepared the draft paper on which this report is based. Robin Clarke, working in close cooperation with Jacqueline Aloisi de Larderel, Kirsten Oldenburg, Sybren de Hoo and John Kryger of UNEP/IE, prepared the final version, combining the ideas in the draft paper with other documents.

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THE NEED FOR CLEANER PRODUCTION

Developing countries face a dilemma today. While economic development is solving problems of poverty it is causing new environmental problems. As a result, air, water and land become more polluted and degraded, and in the more advanced developing countries there is already a need for clean-up operations. Cleaner production can provide solutions to some of these problems. But it requires international cooperation and new policies in the field of industry and the environment that provide incentives to adopt the cleaner production approach.

WHAT IS CLEANER PRODUCTION?

Over the past 30 years, the industrialized nations have responded to pollution and environmental degradation in four characteristic ways:

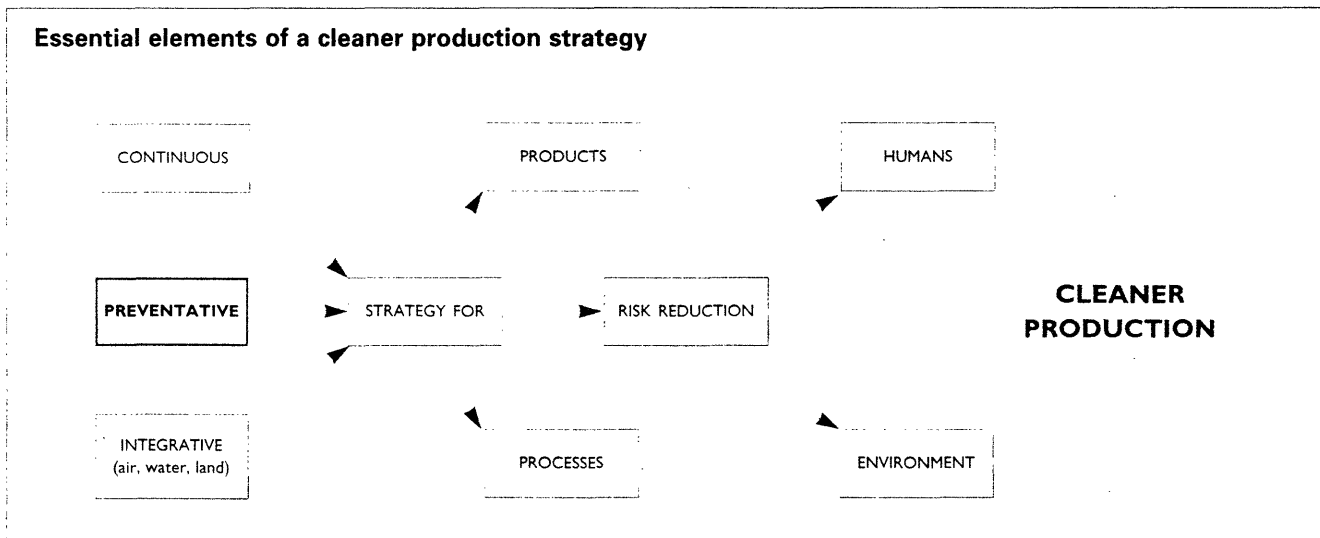
- ❖ first, by ignoring the problem;
- ❖ secondly, by diluting or dispersing the

pollution, so that its effects are less harmful or apparent;

- ❖ thirdly, by trying to control the pollution and the wastes (the so-called 'end-of-pipe' or pollution control approach); and
- ❖ fourthly, and most recently, by cleaner production through the prevention of pollution and waste generation at the source of production.

The sequence of 'ignore, dilute, control and prevent' is one which has culminated in an activity which combines maximum positive effects on the environment with substantial economic savings for industry and society. Achieving this is, essentially, the goal of cleaner production—defined as the continuous use of industrial processes and products to prevent the pollution of air, water and land, reduce wastes at source, and minimize risks to the human population and the environment. The essential elements of the cleaner production definition are summarized in the flow chart below.

'Cleaner production ... is the continuous use of industrial processes and products to prevent the pollution of air, water and land, to reduce wastes at source, and to minimize risks to the human population and the environment.'



Examples of cleaner production techniques

IMPROVE HOUSEKEEPING

Reduce raw material and product loss due to leaks, spills, drag-out, and off-specification solution.

Improve monitoring of operations and maintenance of all facets of the production process.

Schedule production to reduce equipment cleaning—for example, formulate light before dark paints so that vats do not have to be cleaned out between batches.

Train employees in cleaner production.

Improve management of inventory of raw materials and products.

CHANGE PROCESS TECHNOLOGY

Filtration and washing: Use countercurrent washing, and recycle used solvent.

Parts cleaning: Use mechanical cleaning devices; improve draining before and after cleaning; use plastic-bead blasting.

Surface coating: use electrostatic spray-coating system; use powder coating systems; use airless air-assisted spray guns.

CHANGE PRODUCT

Batteries: replace heavy metals (such as cadmium, lead, mercury and nickel) in batteries with less toxic materials.

Spray cans: replace volatile chemicals with water-soluble formulation as aerosol.

Refrigerators: replace CFCs with ammonia or other environmentally-safe materials.

CHANGE INPUT MATERIAL

Printing: substitute water-based ink for chemical solvent-based ink.

Textiles: reduce phosphorus in wastewater by reducing use of phosphate-containing chemicals; use ultraviolet light instead of biocides in cooling tower.

Electronic components: replace water-based film-developing system with a dry system.

REUSE MATERIALS ON-SITE

Printing: use a vapour-recovery system to recover organic solvents.

Textiles: use ultrafiltration system to recover dye-stuffs from waste water.

Metal rules: recover nickel-plating solution using an ion-exchange unit.

Cleaner production can be applied to the processes used in any industry industrial products themselves. For production processes, cleaner production results from one or a combination of the following measures: conserving raw materials, water and energy, eliminating toxic and dangerous raw materials, and reducing the quantity and toxicity of all emissions and wastes at source during the production process. For products, cleaner production aims to reduce the environmental, health, and safety impacts of products over their entire life cycles, from raw material

extraction, through manufacturing and use, to the 'ultimate' disposal of the product.

The key difference between pollution control and cleaner production is one of timing. Pollution control was an after-event, 'react and retreat' approach; cleaner production is a forward-looking, 'anticipate and prevent' philosophy. Prevention, as well known, is always better than cure.

This is not to claim that end-of-pipe technologies will never be required. The new approach is to tackle problems using a cleaner production

Use cleaner production approach first, make decisions about technology later

Cleaner production assessment identifies options for:

- IMPROVED PRODUCT DESIGN
- IMPROVED MANAGEMENT
- IMPROVED HOUSEKEEPING
- SUBSTITUTIONS FOR TOXIC AND DANGEROUS MATERIALS
- PROCESS MODIFICATIONS
- INTERNAL REUSE OF WASTE PRODUCTS

These lead to better planning and selection of

- * NEW PROCESS TECHNOLOGIES

which lead to increased efficiency, and smaller and fewer

- * END-OF-PIPE TECHNOLOGIES

philosophy, which will lead to a better selection and planning of technology. This will lead to a reduced need for end-of-pipe technologies and may in some cases even eliminate the need for them altogether.

Cleaner production can be achieved in a number of different ways, of which the three most important are:

- ❖ changing attitudes;
- ❖ applying know-how; and
- ❖ improving technology.

It is important to stress that cleaner production is not simply a question of changing technology: changing attitudes means finding a new approach to the relationship between industry and the environment, and simply re-thinking an industrial process or a product in terms of cleaner production may produce the required results without importing new technology.

Applying know-how means improving efficiency, adopting better management techniques, changing housekeeping practices, and revising policies, procedures and institutions as necessary.

There are several ways of improving technology. For example:

- ❖ change process or manufacturing technology;
- ❖ change input materials;
- ❖ change the final product; and
- ❖ reuse materials on-site, preferably within the process (off-site recycling is not part of cleaner production, though it may bring substantial environmental benefits).

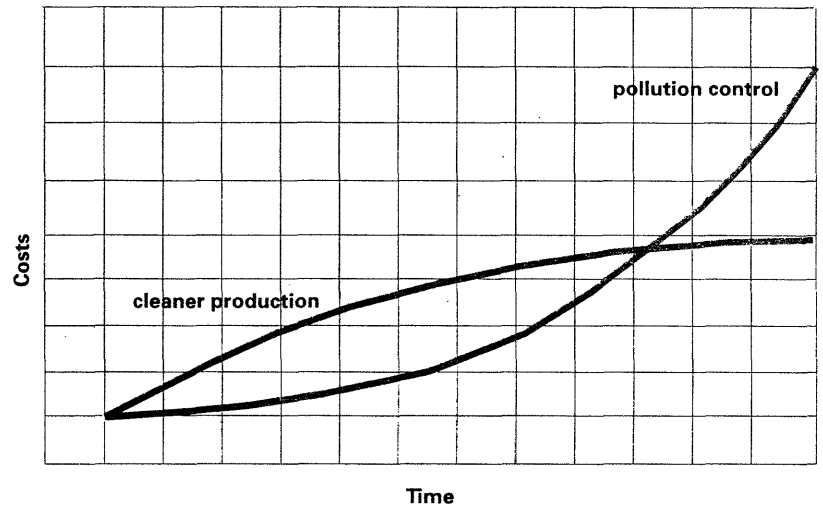
Examples of these processes are given in the box on page 4.

Individuals and industries may be richly rewarded for taking preventive environmental action in the form of cleaner production. Experience in both developed and developing countries shows that this new approach not only produces a cleaner environment but also results in substantial savings for industry and society (see box right).

Cleaner production in practice

- ❖ a cement company in Indonesia has used cleaner production techniques to improve process control, thus saving US\$350 000 a year—payback period was less than one year;
- ❖ a metal treatment company in Singapore installed a new cleaner production process that saved US\$87 000 a year—payback period was two years;
- ❖ the decision to recycle chromium in a Greek tannery reduced chromium pollution and waste from about 30 to about 4 per cent, and saved US\$43 500 a year—payback period was 11 months;
- ❖ a study of painting processes in a Polish steel industry suggests that changing the painting technology could reduce wastes, cut down on solvent and paint use, and save thousands of dollars a year for a capital investment that would be repaid in a few months.

Graph on right shows how costs of pollution control technologies keep on increasing while those of cleaner production soon level off. Investing in cleaner production has a payback time as a result of lower costs. Investments made in end-of-pipe technologies to control pollution are never paid back.



Source: TME, The Netherlands, 1992

Arguments for investing in cleaner production

Cleaner production

- ❖ is the most fundamental approach;
- ❖ leads to product and process improvements;
- ❖ saves on raw materials and energy, and thus reduces production costs;
- ❖ increases competitiveness through the use of new and improved technologies;
- ❖ reduces the need for more restrictions and prohibitions;
- ❖ reduces risks from on- and off-site treatment, storage and disposal of toxic wastes;
- ❖ improves the health and safety of employees;
- ❖ improves a company's public image; and
- ❖ reduces the cost of increasingly expensive end-of-pipe solutions.

Cleaner production can be—and has already been—applied to raw material extraction, manufacturing, agriculture, fisheries, transportation, tourism, hospitals, energy, information systems (for example in process control) and the organization of work.

CLEANER PRODUCTION AND SUSTAINABLE DEVELOPMENT

Both developed and developing countries have often introduced technologies without realizing how much it was going to cost to control pollution from them. They have then argued that a trade-off has to be made between economic growth and the environment, and that some level of pollution must be accepted if reasonable rates of economic growth are to be achieved. This argument is no longer valid, and the UN Conference on Environment and Development (UNCED), held in Rio de Janeiro in June 1992, established new goals for the world community which involve

environmentally-benign forms of development.

Cleaner production can contribute to the sustainable forms of economic development endorsed in UNCED's Agenda 21 (see chapters 20, 30 and 34). Cleaner production can minimize or eliminate the need to make trade-offs between economic growth and environment, between worker safety and productivity, and between consumer safety and competition in international markets. Optimizing several goals at the same time in this way leads to 'win-win' situations in which everyone gains. Cleaner production is such a 'win-win' strategy: it protects the environment, the consumer and the worker while improving industrial efficiency, profitability and competitiveness.

Cleaner production is also now especially attractive to developing countries and those undergoing economic transition because it provides industries in these countries, for the first time, with an opportunity to 'leap

frog' over older, more established industries which are still saddled with costly pollution control technologies. Thus countries that start to adopt cleaner production now will be able to take full advantage of a rare window of opportunity which for once favours developments in poorer countries over those in the industrialized nations.

WHY INVEST IN CLEANER PRODUCTION?

Investing in cleaner production, to prevent pollution and to improve natural resource use, is cheaper than continuing to rely on increasingly expensive end-of-pipe or pollution control technologies. As the graph on page 6 shows, the initial investment for pollution control and cleaner production processes may be similar. But over time pollution control costs continue to mount while cleaner production investments level off. By 1989, the OECD countries alone were spending US\$22 billion a year to control the spread of the 310 million tonnes of hazardous wastes generated every year.¹

As has been said, cleaner production is quite distinct from the traditional pollution control strategy which relies on 'end-of-pipe' technologies. Cleaner production is inherently more preventive, whereas pollution control strategies accept waste, emissions and effluents as a 'given' and try to find ways to handle them or minimize their effects. Pollution control technology, once purchased, is often not properly maintained and its future environmental benefits can therefore be illusory. This is the inevitable result of a technical fix that seeks to treat the symptoms

of a problem rather than address its causes. When cleaner production and pollution control options that solve the same environmental problems are properly evaluated against one another, the cleaner production options will usually be less costly to implement, operate and maintain over the long term (or even the short term) because of reduced costs for raw material, energy, pollution control, waste treatment and clean-up, and regulatory compliance. Payback times can vary between a few months to a few years. In addition, the environmental benefits and performance are greater.

This latter benefit can be translated into market opportunities for 'greener' products. Systems and products for which good environmental performance has been factored in at the 'design' stage will be cheaper to operate and maintain, as well as less polluting and therefore less harmful to human health. Cleaner production therefore provides industries with a new range of benefits (see box on page 6). It also introduces them to new tools such as Life Cycle Assessment and Eco-labelling.

Cleaner production is now especially important for developing countries, many of which are expanding industrial production quickly. As much is clear from the remarkable increase in the chemical exports to developing countries, which almost doubled their share of worldwide trade in chemicals from 7.4 per cent in 1980 to 12.9 per cent in 1991.² With industries expanding this fast, it will become imperative that developing countries seize the opportunity to invest relatively cheaply in cleaner production now rather than pay heavily later

'... at the Beijing Brewery in China, cleaner production techniques, for example, reduced beer losses by nearly 20 per cent, providing annual savings of US\$200 000 while at the same time reducing the chemical oxygen demand of wastewaters. These changes required no investments, only management improvements.'

'Industries and nations embracing cleaner production will find that in so doing they will automatically fulfil many of their international obligations to the environment.'

for clean-up operations, as the industrialized nations have had to do. Doing so will also provide developing countries with a competitive edge over those firms long since established and now encumbered with expensive end-of-pipe control technologies.

Cleaner production is also important for the former centrally-planned economies of Eastern Europe where a transformation to cleaner production presents different challenges. While it is clear that cleaner production policies cannot be transferred uncritically from industrialized countries to developing or re-developing nations, carefully targeted, phased and staged approaches may be timely, and economically and ecologically beneficial.³

CLEANER PRODUCTION CAN BE PRACTISED NOW

It is often claimed that cleaner production technologies do not yet exist and that, where they do exist, they are already patented and can be obtained only through expensive licences. Both statements are untrue.

Cleaner production approaches are widely and readily available, and techniques do exist for identifying and evaluating needed technologies. While it is true that cleaner production technologies do not yet exist for all industrial processes and products, it is estimated that 70 per cent of all current wastes and emissions from industrial processes can be prevented at source by the use of technically sound and economically profitable procedures.³

Secondly, cleaner production depends only

partly on new or alternative technologies. It can also be achieved through improved management techniques, different forms of work organization and many other 'software' approaches to industrial products and processes. Cleaner production is as much about attitudes, approaches and management as it is about technology. This is why it is called cleaner production and not cleaner technology. A good example of this occurred recently at the Beijing Brewery in China, where cleaner production techniques, for example, reduced beer losses by nearly 20 per cent and thus provided annual savings of US\$200 000 while at the same time reducing the chemical oxygen demand of wastewaters. These changes required no investments, only management improvements.

FULFILLING INTERNATIONAL OBLIGATIONS

Finally, while cleaner production is a means of improving industrial performance and protecting the environment, it is equally an effective device for complying with the complex array of rules and regulations designed to protect the environment. This is obviously true, for example, for local government regulations that specify levels of permitted discharges into the air and water. But it is also true of the new and more demanding requirements for international adherence to conventions on ozone-depleting substances, the discharge of toxic materials, climate change and biodiversity. Industries and nations embracing cleaner production will find that in so doing they will more easily fulfil many of their international obligations to the environment.

THE OVERALL STRATEGY

Five important steps are involved in establishing the necessary pre-conditions for a cleaner production programme (see illustration on page 11):

- ❖ establish a shared vision of how to promote cleaner production—'start small but think big';
- ❖ build a consensus that the best way forward is through cleaner production;
- ❖ assess the existing system of environmental and industrial policy—with techniques and procedures for identifying areas and sectors requiring change—and take corrective action;
- ❖ establish cleaner production programmes such as demonstration projects and similar small-scale activities; and
- ❖ provide long-term finance and technical assistance.

'Start small but think big' is a strategic approach that avoids the common pitfall of

trying to do too much too quickly. This approach also stresses the need to distinguish the short from the long term.

The long-term goal may be to introduce cleaner production to every industry in the country through the establishment of key advisory and information centres on cleaner production and technology, and thus effect a nation-wide transformation of industrial practice and philosophy.

The short-term goal may be simply to set up one effective cleaner production demonstration project that will launch a snowball effect throughout a specific region or industry sector, which will eventually spread to other regions and other industries.

It is no bad thing to start small, and it is a mistake to imagine that because funds and human resources are limited nothing can be done. The existence of both the United

National Cleaner Production Centres (NCPCs) under preparation or in operation

UNIDO/UNEP are selecting a number of countries for NCPCs from the following short list:

- ❖ Brazil
- ❖ China
- ❖ India
- ❖ Indonesia
- ❖ Mexico
- ❖ Tanzania
- ❖ Zimbabwe

US-AID has NCPCs in operation in

- ❖ Tunisia
- ❖ Chile

Malta has funded its own NCPC which is already in operation.

The Australia Centre for Cleaner Production

The Australia Centre for Cleaner Production in Melbourne, Victoria, was established in 1993 and works in close contact with the UNEP Cleaner Production Programme (see box on page 27). Its vision is 'to assist industry to achieve the dual goals of international competitiveness and environmental excellence through cleaner production'. It does this through consultation, education and technology transfer. More specifically, the Centre:

- ❖ promotes cleaner production;
- ❖ provides an interface between industry, government and academia;
- ❖ helps set up demonstration projects in industry;
- ❖ provides practical training courses and workshops;

- ❖ helps with strategic development, process audits and opportunity identification;
- ❖ provides information and technology transfer;
- ❖ maintains close links with UNEP and similar programmes in neighbouring countries; and
- ❖ catalyses collaboration between suppliers and customers.

The Centre is expected to become self-financing within three years, and was initially seeded with money from industry, the Victoria Environment Protection Authority and the Department of Business and Employment.

Potential actors in cleaner production programmes

main interest: environment

- ❖ politicians
- ❖ government departments concerned with the environment, public health, worker health and safety, and consumers and product safety
- ❖ non-government organizations representing the environment and consumers
- ❖ consumers
- ❖ trade unions
- ❖ consultants on the environment
- ❖ academics and professionals

main interest: industry

- ❖ politicians
- ❖ government departments connected with economic and industrial planning, commerce and trade
- ❖ multinational corporations
- ❖ large and small national companies
- ❖ joint venture partnerships
- ❖ industrial managers
- ❖ industrial suppliers
- ❖ industrial consultants
- ❖ trade associations
- ❖ Chambers of Commerce
- ❖ academics
- ❖ professional societies
- ❖ financial institutions for venture capital, and national and international loans
- ❖ insurance companies
- ❖ trade unions

main interest: mixed

- ❖ the media
- ❖ politicians
- ❖ interministerial committees
- ❖ local government
- ❖ financial institutions
- ❖ Cleaner Production Centres

Nations Environment Programme and the Industry and Environment Programme within it are proof that small beginnings can lead to major results.

ESTABLISH A SHARED VISION AND CONSENSUS

The initial task in the development of a shared vision and consensus is to identify key people and key institutions that will form the backbone of the cleaner production initiative. It may be that the people and one of the key institutions can be combined to form the nucleus of a Cleaner Production Centre. This has been done in a number of industrialized countries, including Australia, and in developing countries supported by the joint UNIDO/UNEP National Cleaner Production Centre Programme (Phase I of which is sponsored by Austria, Denmark and the Netherlands) or the US-AID Environmental Pollution Prevention Programme (EP3). Some centres have been financed by the countries themselves (see box on page 9).

One of the first jobs of such a centre is to publicize, in a joint effort with government, the need for cleaner production and the importance of the vision that it entails. It is never sufficient simply to approach key leaders in business and government because many, quite unexpected organizations are likely to become involved in cleaner production programmes. The list on the left summarizes some of the more obvious,

Getting the message across to all these groups means that the main job for those who initiate cleaner production approaches is information dissemination: Australia's

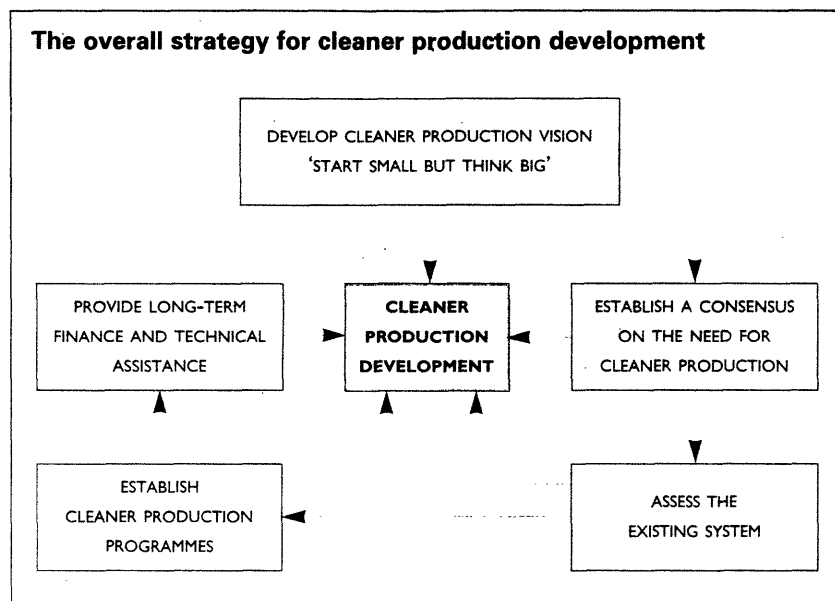
National Cleaner Production Centre, for example, devotes a great deal of its time to presentations, lectures, writing articles and preparing training programmes.

An important key to establishing a shared vision and consensus is for government to proclaim cleaner production as a national priority. Several countries have already done this. For example, the US Pollution Prevention Act of 1990 states that 'The Congress hereby declares it to be the national policy of the United States that pollution should be prevented or reduced at the source wherever feasible ...'. China, Denmark, France, India and Poland (see box on page 11) have also made similar pronouncements. At the same time, this national priority needs to be translated into action. Inevitably, this means providing financial encouragements, for example in the form of grants or low-cost loans, for industries willing to take the first steps.

One of the first jobs for any national cleaner production centre is to set up a cleaner production network to link together those interested in the subject within the country, and to put them in touch with experts elsewhere.

ASSESS THE EXISTING SYSTEM

Before cleaner production policies and programmes can be formulated and implemented, governments need to gain a clear understanding of how their existing system works. This will reveal a number of obstacles that are likely to hinder adoption of cleaner production, and which will have to be removed. In the process the



opportunity can be taken to introduce cleaner production approaches to industrial and environmental legislation, and to develop specific cleaner production initiatives. A bias towards pollution control might be found, for example, in:

- ❖ innovation policy;
- ❖ industrial policy;
- ❖ raw material pricing;
- ❖ trade policies;
- ❖ tax systems;
- ❖ educational curricula;
- ❖ environmental regulations; and
- ❖ technology development.

Governments must also understand exactly what cleaner production means at the level of industry. This is often misunderstood, which leads to inadequate policies to promote cleaner production or to the idea that cleaner production does not warrant separate attention at the policy level. This

point is examined in more detail in the next chapter.

ESTABLISH CLEANER PRODUCTION PROGRAMMES

A cleaner production programme incorporates demonstration projects, education, training, capacity building, outreach and institution building. For industry, the first job is to carry out the same kind of assessment as governments do, but at the manufacturing level. A specific tool, the cleaner production opportunities audit, is available for this purpose, and has been successfully used in many demonstration projects. It is used to examine an industry's production processes, evaluate the changes that could be made and estimate their costs. One such manual is available from UNEP and UNIDO.⁴ In practice, however, there is a

The Polish Declaration on Cleaner Production

In view of the need for a profound reconstruction of Polish industry, a Declaration on Cleaner Production has been formulated by the Ministry of Environment, Natural Resources and Forestry and the Ministry of Trade and Industry. The aim of this declaration is to develop the economy and preserve the natural environment.

It is proposed to introduce the principles of preventive environmental management into the production and development programme of companies in order to achieve sustainable industrial development.

These principles aim at minimizing solid, liquid and gaseous wastes in the production process, while simultaneously providing economic benefits.

For the implementation of the declaration:

The Enterprise

- ❖ will prepare and implement a Cleaner Production Project according to the UN methodology;
- ❖ will introduce the Project into short- and long-term production and development plans and arrange for periodical reporting;
- ❖ will designate a supervisor for the Project.

Ministry of Environment, Natural Resources and Forestry and Ministry of Trade and Industry

- ❖ will organize training courses in the methodology of Cleaner Production design;
- ❖ will facilitate access to information about world solutions in this area;
- ❖ will support enterprises seeking finance for the most effective undertakings resulting from Cleaner Production Projects.

The UNEP/UNIDO cleaner production assessment⁴

PHASE 1: PREASSESSMENT

AUDIT PREPARATION

- ❖ prepare audit team and resources
- ❖ divide process into unit operations
- ❖ construct process flow diagrams linking unit operations

PHASE 2: MATERIAL BALANCE

PROCESS INPUTS

- ❖ determine inputs
- ❖ record water usage
- ❖ measure levels of waste reuse/recycling

PROCESS OUTPUTS

- ❖ quantify products/by-products
- ❖ account for wastewater
- ❖ account for gaseous emissions
- ❖ account for off-site wastes

DERIVE A MATERIAL BALANCE

- ❖ assemble input and output information
- ❖ derive preliminary material balance
- ❖ evaluate and refine material balance

PHASE 3: SYNTHESIS

IDENTIFY WASTE REDUCTION OPTIONS

- ❖ identify obvious waste reduction measures
- ❖ target and characterize problem wastes
- ❖ investigate waste segregation
- ❖ identify long-term waste reduction measures

EVALUATE WASTE REDUCTION OPTIONS

- ❖ undertake environmental and economic evaluation of waste reduction options

WASTE REDUCTION ACTION PLAN

- ❖ design and implement a waste reduction plan to improve process efficiency

need to produce manuals for individual countries and, indeed, for different types of industry within each country. Manuals of this type are now available in a number of countries including the Austria, China, Denmark, India, the Netherlands,⁵ Norway, Poland⁶, Sweden, the United Kingdom and United States.⁷ In the Netherlands, the PRISMA project, working with small and medium-sized firms, has successfully carried out assessments and cleaner production demonstration studies in 10 industries. Details of the UNEP/UNIDO and US EPA/PRISMA assessment approaches are illustrated on this and the facing page.

Note that the assessment process is not a one-off, start to finish procedure. Once the assessment has been made, and a cleaner production approach adopted, the results must be monitored and evaluated. This evaluation will provide feedback to improve the innovations introduced; it will also suggest new areas for application of cleaner production concepts. At this point the assessment cycle should be repeated.

The lessons learned are currently being applied in a much larger project in China, supported by UNEP/IE and the World Bank (see box on page 27). This project was designed to pay particular attention to the need for information by policy makers and to different dissemination strategies for cleaner production. The China project is part of a well designed demonstration programme in which more than 30

companies take part in the development of policy studies which are then used to provide a 'tailor-made' cleaner production policy for each country. The Chinese project began with a series of wide-ranging assessments in five major areas:

- ❖ innovation and industrial policies;
- ❖ environmental policies at national level;
- ❖ environmental policies at local level, with some emphasis on the permit system;
- ❖ cleaner production policies abroad; and
- ❖ the introduction and implementation of cleaner production in companies, and the obstacles that arose, on the basis of a series of case histories.

These evaluations are made with the help of in-depth interviews with important individuals and collective brainstorming sessions in workshops involving representatives from industry and government. However, a key to their success was the establishment of a number of cleaner production demonstration projects in individual companies, where the emphasis was on training and education of Chinese experts and on relatively cheap ways of implementing cleaner production, notably:

- ❖ management improvements;
- ❖ good housekeeping;
- ❖ substitution of toxic materials;
- ❖ process modifications;
- ❖ internal reuse of wastes; and
- ❖ changes in product design.

Demonstration projects of this kind are useful in revealing obstacles to progress both within companies and in the relationship of companies to the outside

The diagram on the left, reproduced from the original publication, uses the term 'waste reduction' in place of 'cleaner production'.

world, notably with local and national government agencies.

These obstacles are different in every country. However, demonstration projects already carried out in Europe and Asia show that five different kinds of obstacles can exist (a finding that has been confirmed by research and demonstration projects in a number of developing countries). These obstacles are:

- ❖ conceptual;
- ❖ organizational;
- ❖ knowledge-based;
- ❖ technical; and
- ❖ economic.

Governments need to have a clear picture of these obstacles in order to frame tailor-made policies to overcome the obstacles.

Conceptual obstacles relate to issues which companies regard as important. Conceptual obstacles can include a lack of importance given to the environment, resistance to change, and poor environmental standards in both companies and governments.

Organizational obstacles can be traced back to the way a company is organized, to the ways in which companies work together and the ways in which government's environmental and innovation policies are organized. In government, for example, it is difficult to give cleaner production proper priority if environmental policy is organized by individual sector, such as water, air and land, because cleaner production covers them all.

Knowledge-based obstacles usually relate to a lack of knowledge about cleaner

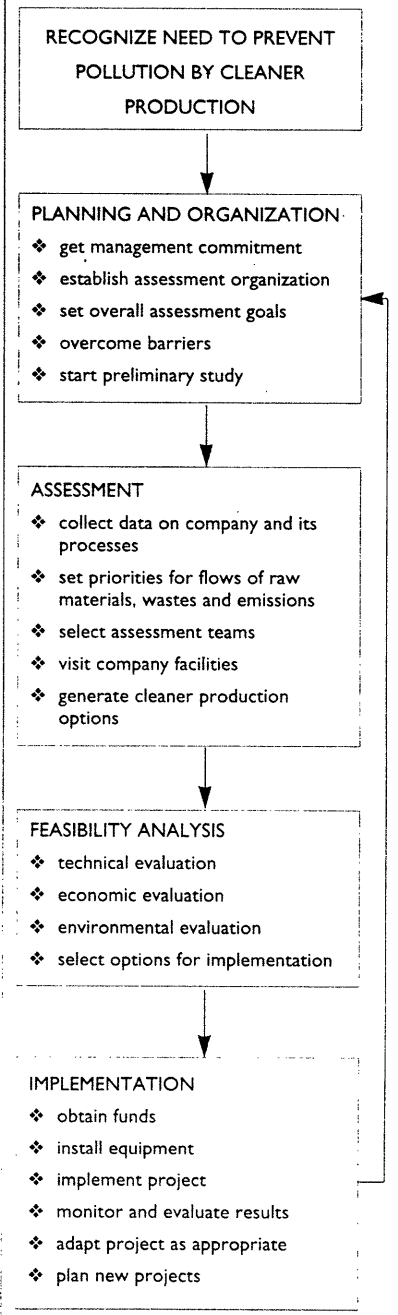
production. Many professionals in companies and governments do not know how to obtain information about cleaner production, often because it cuts across the conventional technical, economic, organizational, social psychological, environmental and managerial divisions.

Technical obstacles are common because technical changes are often involved in cleaner production. The need to master techniques of cleaner production assessment and change installations, tools, input materials, processes and products often reveals technical obstacles, sometimes at the stage of technology development, sometimes during demonstration and sometimes during dissemination.

Economic obstacles are also common, despite the fact that cleaner production usually results in potential savings for both industries and governments. Common economic obstacles include vested interests, shortage of investment funds, and incomplete or incorrect allocations of costs during the economic analysis of cleaner production possibilities. One of the most common economic obstacles is a pricing policy that in effect subsidizes the use of resources such as energy and, particularly, water.

Cleaner production is an approach that can be successfully applied in small and medium-sized enterprises as well as in large ones. Indeed, it may be that smaller companies need to adopt cleaner production approaches more urgently than large ones because small companies rarely have the resources to stay in business if they make major mistakes. Adopting cleaner production

The US EPA/PRISMA cleaner production approach⁵



'Another small UK company, with a staff of only 13 people, has developing a new method of galvanizing steel that eliminates conventional wastes, uses less zinc, gives better process control, reduces labour and provides safer working conditions. The new plant pays for itself within three years, reduces capital investment by two-thirds and costs only 18 percent of the cost of the steel itself, compared to 60 percent with traditional methods.'

is a way of reducing risks, risks that smaller businesses cannot comfortably afford to take. Heavy fines, for example, imposed on companies producing excessive waste have bankrupted many small businesses.

There are many examples of successful cleaner production innovations in small and medium-sized companies. In the United Kingdom, for example, a small research-based company has developed a range of water-based adhesives to replace solvent-based ones. Users have found that the new products have many economic advantages as well as being non-toxic and non-polluting: they require three to five times less drying energy, reduce the need for safety precautions and solvent-recovery systems, and save on equipment and raw materials.

Another small research team has produced a means of optimizing the performance of coal-fired cement kilns, thus saving an Indonesian company 3 percent in fuel, 40 percent in off-specification product and increasing capacity by 9 percent. Another small UK company, with a staff of only 13 people, has developed a new method of galvanizing steel that eliminates conventional wastes, uses less zinc, gives better process control, reduces labour and provides safer working conditions. The new

plant pays for itself within three years, reduces capital investment by two-thirds and costs only 18 percent of the cost of the steel itself, compared to 60 percent with traditional methods.

PROVIDE LONG-TERM FINANCE AND TECHNICAL ASSISTANCE

Several types of technical assistance have already been mentioned in the description of the establishment of a cleaner production programme. The emphasis should be on the need for a cleaner production assessment, cleaner production training and well-designed demonstration projects. Long-term and ongoing support will also require appropriate institutions, such as a National Cleaner Production Centre.

Long-term finance is an important aspect of launching a cleaner production programme, and can be provided in several ways. First, a long-term commitment to finance a cleaner production programme will show that government really does give cleaner production a high priority. Secondly, technical support can be financed by governments and industry organizations on a programmatic basis which has more impact than the relatively isolated financing

of individual cleaner production events.

Thirdly, 'revolving funds' can be established for small and medium-sized companies. The money from such funds is used to finance a cleaner production audit and select beneficial options. Companies re-pay the fund from the economies that they achieve.

MOVING FORWARD

A vision and a series of well designed demonstration projects are sufficient to start the cleaner production ball rolling. In China, progress will be achieved in four stages: preparation, demonstration, policy studies and finally dissemination. Furthermore, although the Chinese project is small in relation to many development projects, it is expected to result in the application of cleaner production in more than 3000 Chinese companies within five years of the start of the project. This is a good example—and there are many others—of how the 'start small but think big' approach can produce substantial yields.

These yields, however, will not be realized unless government has also prepared an appropriate environment in which to plant the seeds of cleaner production. The following chapter analyses the legislative and economic tools available to governments wishing to establish such an environment.

A TOOL-BOX OF POLICIES

'While it is industry that ultimately must implement cleaner production, the role of government is to lead by providing an environment that will accelerate the process and encourage industry to initiate its own cleaner production programmes.'

While it is industry that ultimately must implement cleaner production, the role of government is to lead by providing an environment that will accelerate the process and encourage industry to initiate its own cleaner production programmes.

The range of tools available for governments trying to catalyse industry to adopt cleaner production is large, and different countries will select those combinations of tools they regard as most suited to their needs. The boxes on pages 18–20 list a number of such policy instruments, as examples. The text that follows, however, analyses these and other tools under four different categories:

- ❖ applying regulations;
- ❖ using economic instruments;
- ❖ providing support measures; and
- ❖ obtaining external assistance.

In industrialized countries, the first three of these tools have generally been applied in the order given above (see table opposite). The last tool, obtaining external assistance, is specially relevant to developing countries and those undergoing economic transition. Governments, in other words, have first established regulations designed to limit emissions to the air, water and onto land. They have then introduced economic instruments that encourage the observance of these regulations and penalize their infringement. Finally, they have provided support for industries to enable the regulations to be more easily met. In the process, developed countries have acquired extensive and complicated regulatory systems.

Regulations have not been introduced on such a massive scale in developing countries, and it is not yet clear whether they will need to do so. They certainly do not have to be in place before launching a cleaner production offensive. The implementation of cleaner production, with its goals of zero emissions and full recycling, does not necessarily depend on the existence of an extensive regulatory system. Developing countries may well find it more feasible to depend on raising awareness of the economic benefits implicit in cleaner production. Coupled with suitable support measures and the use of external assistance, this will be enough to persuade many industrial leaders to adopt cleaner production procedures, with regulations and economic instruments playing a less important role than they have in the industrialized countries.

Nevertheless, all four sets of tools are described in detail below since all will be used to some extent. While regulations and economic instruments have been extensively used to produce generalized environmental improvements, there are fewer examples so far of their specific use to catalyse cleaner production.

APPLYING REGULATIONS

Regulations can be used to specify an environmental goal—such as reduction of carbon dioxide emissions to 1985 levels—without necessarily stating how the goal is to be achieved or what technology is to be used to achieve it. Alternatively, regulations can specify that a certain technology must be used in certain industries to reduce pollution, but the environmental goal may

Differences in the use of policy instruments in the states of the European Union and the United States

	NL	DK	SP	UK	FR	BE	GE	PO	IT	GR	EI	LU	USA
Legislation													
Approval scheme including cleaner technology	●	●	○	●	○	○	○	○	○	○	▲	●	●
Voluntary agreements	●	●	○	○	○	○	●	○	○	○	○	▲	●
Financial instruments													
Tax, duties and fees	●	●	○	○	●	▲	●	○	○	○	○	○	●
Grants and subsidies	●	●	●	●	●	●	●	●	▲	●	○	●	●
Information and education													
Demonstration projects, processes	●	●	○	●	▲	●	●	○	○	○	○	○	●
Demonstration projects, products	●	●	○	○	○	●	●	○	○	○	○	○	○
Consultant support	●	●	●	●	●	●	○	○	●	○	●	○	●
Centres of expertise	●	○	○	●	○	●	●	○	●	○	●	○	●
Newsletters	●	●	○	●	○	●	○	○	○	○	●	○	●
General manuals	●	●	▲	●	●	●	○	▲	○	○	○	○	●
Industry-specific manuals	●	●	○	▲	○	▲	○	○	○	○	○	○	●
Databases	●	●	●	○	○	●	○	○	○	○	○	○	●
Videos	●	●	○	○	○	○	○	○	○	○	○	○	●
Conferences and seminars	●	●	○	●	●	●	○	▲	○	○	●	○	●
Research and development programmes	●	●	○	●	●	●	●	○	●	●	●	○	●

● : yes ▲ : under preparation ○ : no activities or no information

be left unspecified. The most rigid regulations specify both the target and the technology to be used to achieve it.

Specified and negotiated compliance

In the industrialized countries, regulatory programmes are the foundation on which environmental quality has been built. In this sense, their use has been relatively

successful since the clean-up operations effected in the OECD countries, for example, have significantly improved environmental conditions. These countries have relied mainly, though not exclusively, on what is known as 'specified compliance': precise and specific demands have been imposed on the regulated communities, with little bargaining allowed and few exceptions made. This somewhat authoritarian style of government has

Sources: Commission of the European Union, DG XI, *Waste Management: Clean Technologies—Update on Situations in Member States*, Brussels, June 1994, draft; and J. Hirschhorn and K. Oldenburg, *Prosperity without Pollution*, Nostrand and Reinhold, New York, 1991.

Table above gives an overview of the large differences that exist in the use of policy instruments in the European Union Member States and the United States. Cleaner production is an emerging concept which is being steadily incorporated into national policy. The table does not imply anything about the efficiency of the policy instruments in place in each country.

Some cleaner production policy instruments

ESTABLISH CLEANER PRODUCTION PROGRAMMES

States and local governments can establish cleaner production programmes. These programmes can be institutionalized within an environmental or industry agency or within an academic institution. The main purpose of these programmes and their centres of expertise is to increase awareness of cleaner production and improve capacity in government institutions and industries. These centres of expertise can also play an important role in research and development on cleaner production, in the dissemination of information and in training.

REQUIRE CLEANER PRODUCTION AUDITS

Require industrial firms to prepare formal cleaner production audits of their plants and set up implementation schemes.

PUBLISH ENVIRONMENTAL PERFORMANCE DATA

Make public information on the environmental performance of companies and update the information on a regular basis so that the community (and NGOs) know how responsive local companies are to the need to improve their environmental performance.

PROVIDE TECHNICAL ASSISTANCE

Set up teams of cleaner production experts to provide free advice to industry on how to audit their products

undoubtedly been successful in improving environmental conditions. However, it has its drawbacks: the regulated community tends to become alienated, and united in its opposition to the rule makers; furthermore, this approach encourages the use of expensive pollution control technologies, the adoption of which often reduces the budget available for promoting cleaner production; adapting, testing and putting such techniques into practice can also take as long as implementing cleaner production. Once a pollution control device is in place, there is little incentive to pay more money out to reduce the need for the device.

The 'negotiated compliance' approach, by contrast, seeks to obtain compliance by the use of general and flexible guidelines, and bargaining between the regulators and the regulated. This less adversarial approach, of which the ultimate expression is the voluntary agreement or code of conduct, may be more useful to governments trying to promote cleaner production over the long term. In very broad terms, experience in industrialized countries suggests that specific compliance is the preferred option to achieve urgent, short-term goals while negotiated compliance may be preferable over the long term. But no government currently relies exclusively on either approach.

General principles

A number of general principles surround the efficient use of regulations in developing countries and countries in economic transition:

- ❖ since environmental regulations were originally designed with pollution control

in mind, it is important that governments explicitly consider the implications of using these regulations for cleaner production, which may be profound and not immediately apparent;

- ❖ although it is important for developing countries to establish their long-term environmental goals, they need to allow enough time for these goals to be attained;
- ❖ stricter requirements can often be made for new industries than for those already established, since the latter have to make larger investments to reduce emissions;
- ❖ there is no point in establishing goals if they cannot be implemented and enforced, and if government is not able to ensure compliance; this implies that regulations must be effectively monitored, a process that can prove costly;
- ◆ it is better to specify progressively restrictive performance goals than to apply static requirements, since the latter often lead companies to apply pollution control technologies;
- ◆ goals should be defined so that they must be achieved first as a result of the adoption of cleaner production, followed by the application of pollution control technology if necessary.
- ◆ discretionary regulations, which allow flexibility as to how goals are to be achieved, are preferable to regulations that specify both what must be done and how it is to be done; and
- ◆ the use of voluntary agreements and codes of conduct, backed up by regulations, should be encouraged in different industry sectors; if compliance with such codes is monitored, unnecessary legislation can be avoided; supporting industry

associations is one effective way of stimulating voluntary agreements and monitoring.

USING ECONOMIC INSTRUMENTS

Economic instruments can be used to make the cost of pollution more expensive than the cost of cleaner production. They exist in two forms: those that provide rewards, such as tax rebates, for compliance, and those that penalize, for example through fines, for non-compliance. The revenue generated through the latter should be used, at least partially, to help develop cleaner production approaches.

Economic instruments can be used to shape and direct technological investment, the purchase and use of materials and energy, and the management of pollution and waste. They can provide incentives for cleaner production or they can, if unwisely fashioned, subsidize pollution control or environmentally-harmful industrial activity through, for example, inappropriate taxes and subsidies.

The range of economic instruments includes the following:

- ◆ taxes;
- ◆ reporting requirements and liability;
- ◆ tax incentives; and
- ◆ subsidies.

When carefully crafted, these economic instruments discourage polluting technologies. In theory they are instruments that internalize the social cost of production by imposing an economic

cost or penalty for polluting. Indirectly they also improve the economic rewards for adopting or developing cleaner production by lowering the operating costs of cleaner production relative to production systems using polluting technologies.

Before any of these instruments are applied, governments need to analyse what forms of economic instrument are already in operation, either explicitly or implicitly.

Among the latter are the frequent forms of subsidy used to lower production costs and make industry more competitive with imports and foreign production in general. Many of these policies lead to artificially low prices for resources such as energy and water. As a result, these resources are often used profligately, creating both pollution and shortages. Government assessments are needed of industrial policies such as these before other economic instruments are applied. In general, policies that result in prices that reflect the real costs involved should be implemented before other economic instruments are employed.

Taxes

Taxes on toxic or undesirable inputs and feedstocks, pollution and waste, and energy can go a long way towards discouraging activities that contaminate the environment and work place, contribute to global warming and perpetuate unsafe products. Indirectly, these taxes can establish a more attractive economic environment for the development and utilization of cleaner production.

Many industrialized countries have used or

and processes, and how to devise and evaluate cleaner production solutions.

REVISE EXISTING LAWS AND REGULATIONS

Encourage cleaner production through existing laws and regulations by assigning priority to cleaner production over pollution control, and eliminate the under-pricing of energy, water and raw materials that favours end-of-pipe technology.

SET NEW REGULATIONS

Set new regulations for specific industries that will require them to adopt cleaner production processes or redesign products to meet new standards.

CHANGE PERMITTING SYSTEM

Make sure that a complete cleaner production audit has been conducted to determine what emissions could be prevented. Then set permits allowing emissions of only those wastes that a firm cannot prevent.

ENCOURAGE VOLUNTARY REDUCTION SCHEMES

Establish a programme to encourage industry voluntarily to reduce the generation of the most toxic pollutants by 50 per cent or more within a few (3–5) years, and publish the results annually (for example, more than 300 chemicals are now included in the toxic release inventory in the United States). Use legislation if goals are not achieved in due time.

(continued on page 20)

(continued from page 19)

MAKE SPECIAL ENFORCEMENT PROVISIONS

Help industry by conducting research on major environmental problems, and provide cleaner production support to industries affected by new regulations. Where violations occur, arrange for reductions in fines equal to a percentage of the company's cost of implementing a cleaner production solution to deal with the problem.

CHANGE USE OF TECHNOLOGY STANDARDS

Increase flexibility at company level by formulating standards on the basis of the best available technology and give freedom to industry to select the most appropriate technologies that meet these standards.

PROVIDE SUBSIDIES

Governments can help companies to pay the costs of complying with environmental regulation by subsidising cleaner production solutions.

OFFER GRANTS FOR THE DEVELOPMENT OF CLEANER PRODUCTION TECHNOLOGY

Offer grants to firms and research organizations to support the development of cleaner processes and products.

INVEST REVENUES FROM WASTE TREATMENT AND TAXES IN CLEANER PRODUCTION DEVELOPMENT

Government revenues from waste treatment and taxes on the use of toxic materials and/or raw materials including energy can be invested in promoting cleaner production programmes.

are considering using emissions taxes. One of the difficulties in applying such taxes is that it is often not politically feasible to set such taxes high enough to achieve specific environmental goals. While this is a disadvantage, these taxes can still result in real reductions in pollution levels, even though these may not be of the desired magnitude. In addition, they will raise revenue, and this revenue can be used in other ways to encourage cleaner production, for example by financing tax rebates for good environmental behaviour (this is known in the United States as the 'feebate' system) or to finance cleaner production centres or assistance.

It is generally best to set taxes at a low level to start with so that firms have time to adjust, and then to publish a schedule to higher levels that will allow industry to plan future policies and investments in a more effective way.

Taxes are an indirect way of influencing emission levels, and experience has shown that their effects are not always predictable. It is therefore important that governments make regular evaluations of the effect of emissions taxes in case they produce unexpected and unwanted results.

Reporting requirements and liability

Reporting requirements for pollution and waste can affect public demand and public tolerance of polluting industries, and this can change the behaviour of firms concerned about their public image or management-labour relations. Eco-labelling schemes are a form of reporting

requirement which have been successful in both increasing consumer awareness and in stimulating the development of 'greener' products.

Liability concerns similarly affect the image of the firm but can also exert a powerful direct economic incentive to move away from polluting technologies and unsafe products towards cleaner production. The success of liability systems, of course, depends on how effective is the enforcement and legal system of the country concerned. Several countries have found that enforcing the concept of 'strict liability'—which means that firms are held responsible for all the environmental damage they cause, even if they have fulfilled their legal obligations—often leads companies to try to minimize their risks and take preventative measures. A requirement that a cleaner production assessment should be carried out and reported can help to identify cleaner production options in a way that affects process technology choices and reduces the need for end-of-pipe technologies. Both types of report lead to innovations with a strong cleaner production bias.

Apart from sanctions for particular activities leading to harm to the environment or persons, the requirement that companies maintain sufficient capital reserves to cover the cost of possible future pollution damage may provide a more powerful incentive to move towards cleaner production than sanctions alone. Since such a requirement can affect the required capitalization of the firm, national and international lending institutions are in a position to encourage firms to invest in cleaner production.

Tax incentives

Preferential tax treatment of expenditures for pollution control equipment has been used in many countries to encourage firms to purchase or install devices to control emissions. Similar subsidies exist for treating waste. While these provisions have a social purpose, they also create a bias (supporting perhaps an already-existing preference on the part of the firms to apply pollution-control solutions rather than change their production systems) away from adopting cleaner production. Where cleaner production options exist or could easily be developed, this preferential tax treatment may provide a perverse incentive even though it may have been justified when it was first adopted. Further, government should consider revising tax policy to accelerate the faster retirement of older, polluting technologies and the promotion of cleaner production.

Subsidies

Financial subsidies, in the form of low-interest loans, forgivable loans, direct grants-in-aid, or shared funding can be targeted to specific industries to stimulate either technology development or diffusion, as appropriate. Both are needed.

In countries where central banks are under government control, it is relatively easy to arrange that financing institutions provide favourable terms for companies wishing to invest in cleaner production. Where banks are not under government control, the process is more complicated, and often involves the establishment of special funding mechanisms under government control.

The use of government funds derived from the application of environmental sanctions to stimulate research on cleaner production is attractive (particularly since such research is cheaper, and generally more effective, than basic research). An important form of subsidy is thus for government to support not only individual research projects, but also to facilitate partnerships between government and firms and between firms, as well as involve consultants, academics and NGOs. Government and industry can also fashion demonstration projects which show that an industrial transformation to cleaner production in a specific context can work and is profitable.

PROVIDING SUPPORT MEASURES

Although industry is the prime mover in implementing cleaner production, government support can play a critical role, providing just that bit extra that industry needs to be persuaded to take the plunge. Attention should be directed at four key areas:

- ❖ providing information, about both the technology involved and the environmental tools industry needs to make cleaner production assessments of its activities and products;
- ❖ organizing training on cleaner production;
- ❖ helping to change educational curricula, in order to integrate the environmental dimension in all engineering and business management courses; and
- ❖ assisting key institutions.

'Taxes are an indirect way of influencing emission levels, and experience has shown that their effects are not always predictable. It is therefore important that governments make regular evaluations of the effect of emissions taxes in case they produce unexpected and unwanted results.'

'In countries where central banks are under government control, it is relatively easy to arrange that financing institutions provide favourable terms for companies wishing to invest in cleaner production. Where banks are not under government control, the process is more complicated, and often involves the establishment of special funding mechanisms under government control.'

The International Cleaner Production Information Clearinghouse (ICPIC)

ICPIC was set up by UNEP/IE in 1990 and can be accessed by anyone with a personal computer, a modem and access to a telephone line. It is a menu-driven system with access to several databases, including those on cleaner production case studies, seminars and conferences, publications, international contacts, corporate programme summaries and country programme summaries. ICPIC information is soon to be made available on diskette and in printed form.

ICPIC's number in Paris, France, is (331) 4579 4059. Further information is available by voice from (331) 4437 1425.

Providing information

One of the most commonly quoted barriers to cleaner production is lack of information about appropriate technologies.

Publications, newsletters and direct contacts between cleaner production experts and both government and industry will be badly needed. This is particularly true for small and medium-sized companies. Guidelines are also important in communication. The World Bank/ UNIDO/UNEP *Pollution Prevention and Abatement Guidelines* are an example of this.

One way of providing this information is establishing clearinghouses for cleaner production technologies or cleaner production centres. These systems should be interactive, and thus able to accept information from other countries and international organizations. UNEP maintains its own clearinghouse, the International Cleaner Production Information Clearinghouse, in Paris (see box). UNIDO runs the Industrial and Technological Information Bank (INTIB) and several country-level databases are available. It is important that information systems identify environmentally unsound practices as well as cleaner production technologies.

Secondly, most industries need help in locating information about how to assess their own environmental impacts. Governments can publish and disseminate information on how to perform the most widely used techniques, such as environmental impact assessments, technology options analyses, cleaner production audits and product life cycle analyses. This is particularly important if

governments decide to require companies to make such audits, either regularly or for new projects.

Regulations requiring environmental impact statements for projects undertaken by either government or industry is a familiar and well-developed means of evaluating proposed industrial activities. These have been successfully used to promote pollution control, and the challenge now is to use them to promote cleaner production. The European Bank for Reconstruction and Development, operating in Central and Eastern Europe, requires environmental impact assessments that include alternative approaches to production design and technologies. A comparative environmental impact analysis that includes a detailed technology options analysis could help promote the development of new technologies for cleaner production.

However, the success of such techniques depends on the quality and user-friendliness of the information available and the expertise of government staff to interpret the analysis. Environment agency personnel should be helped by staff from commerce and trade agencies and/or from cleaner production centres wherever possible.

Government may also require a technology options analysis from the proponent of a particular technology as well as a comparative environmental impact analysis so that government can be fully informed of the possible environmental consequences of alternative choices. A technology options analysis includes not only the technologies currently used or proposed, but also alternative technologies that could be

adopted, adapted or developed. For example, proponents of the addition of vapour recovery technology to their degreasing operations should also identify and evaluate ultrasonic cleaning as an alternative technology.

In comparing alternative technological approaches, care should be taken to articulate all the environmental consequences—ecosystem and human health effects in the general environment, the work place, and from exposure to consumer products. The life cycle approach should be used in the assessment of technological options. Full life cycle analysis, however, is often too expensive, too time consuming and demands too much data collection to be worthwhile in all instances.

Organizing training

In order to staff an infrastructure dedicated to cleaner production, adequate training initiatives must be provided. These initiatives should be directed towards changing both the knowledge and the attitudes of the managers of firms, government bureaucrats, technologists and academics, and NGOs. Those trained in science and engineering may not have the appropriate training to develop cleaner production systems. Developed countries are just beginning to appreciate that the skills that are required for cleaner production are different from those required for pollution control. Furthermore, skills to manage technological change are different from those needed for managing existing production systems efficiently. Exchange and rotation of personnel between government and

industry can deepen the understanding of the roles of each and facilitate meaningful partnerships in promoting cleaner production.

Governments wanting to start up training programmes are encouraged to contact the Cleaner Production Programme in UNEP. Module 2 of *Training Approaches for Environmental Management in Industry* is devoted to cleaner production.⁸ UNEP's Cleaner Production Programme is developing additional training materials, including modules that will focus on key issues in starting up and implementing cleaner production programmes. Another valuable source of information is the UNIDO *Training Course on Ecologically Sustainable Industrial Development*, which covers a broad field of environmental issues including cleaner production.

Changing education curricula

Part of any government's long-term plan must be to incorporate environmental concerns into educational curricula in general, and into all engineering and business management courses in particular. Doing so will eventually eliminate the need for a substantial adult education programme in industry, which will often be needed for some time before industrial managers (particularly in small and medium-sized firms) can be persuaded to think about environmental issues in anything but very negative terms.

This implies 'educating the educators' as well as 'training the trainers'. A programme is best worked out jointly between the Ministries of Education, Industry and

'Part of any government's long-term plan must be to incorporate environmental concerns into educational curricula in general, and into all engineering and business management courses in particular.'

'NGOs may be particularly important in building local capacity and pressuring industry to adopt cleaner production.'

'Technological cooperation with foreign or international partners and financial institutions can actually stifle, rather than build, local capacity if care is not taken to make it a two-way process.'

Environment and the National Cleaner Production Centre (if there is one) or a centre of expertise in another institution.

Assisting key institutions

Building infrastructure and capacity in government, industry and NGOs is essential for achieving advances in both development and environmental protection. Infrastructure includes both legislative and institutional/organizational elements. They must all be in place if the initiatives discussed above are to be implemented efficiently. Capacity refers to both institutional capability and to individual capabilities in relation to production systems, policies, initiatives and programmes. These capabilities include understanding, assessing, designing, implementing, maintaining, monitoring, evaluating and changing products, processes and policies.

Small and medium-sized enterprises, which are responsible for much pollution and waste and which could especially benefit from a transformation based on cleaner production, are particularly lacking in the capacity to assess their needs and to request and process information on cleaner production. Written material, interactive information systems, and contacts with cleaner production centres, consultants, academics and other firms are all necessary to bridge the information gap on cleaner production. Similarly consumers, workers, NGOs and unions may initially lack the tools and skills necessary to enable them to participate as full partners in an industrial transformation based on cleaner production on either a broad scale or with regard to a

specific plant or industry. Yet their participation is crucial. NGOs may be particularly important in building local capacity and pressuring industry to adopt cleaner production.

Government should support cleaner production networks which may operate on a national, regional or local level. The creation of interministerial committees or working groups staffed at the highest level is essential. Following this, cleaner production centres need to be funded and established at both the national and regional levels to demonstrate a commitment to cleaner production and an institutional mechanism for its implementation.

Government—as already stressed—needs to send strong signals that it intends to integrate environmental and industrial development policies. Participation of government, industry, NGOs and others in cleaner production projects may be the best capacity-building intervention. Theoretical knowledge and formal education can only go so far. Learning by doing is particularly important for cleaner production because both attitudes and the knowledge base must be changed.

Technological cooperation with foreign or international partners and financial institutions can actually stifle, rather than build, local capacity if care is not taken to make it a two-way process. Furthermore, where capability development is at the core of a particular technology transfer activity, a longer-term commitment is required than is usually offered in a single project. Ultimately, the responsibility for managing technological change lies with the recipient

country, which must take an active role in ensuring that technology transfer, whether financed privately or through development assistance, includes a capacity-building component.

OBTAINING INTERNATIONAL ASSISTANCE

Assistance to developing countries or those with economies in transition can take the form of financial aid or transfer of information and know-how, education, training and hardware. The extent to which the transfer of financial, intellectual and technical resources fosters self-reliance is of key importance in these activities. Capacity-building through technology cooperation must enhance the recipient country's ability to manage technological change, and permeate the culture rather than exist as an isolated capability in a government agency or industry.

International finance

Obviously, financial resources are needed to effect a shift towards cleaner production. The use of domestic funds and other means of persuasion should be used as a lever to access the obviously more substantial funds available from international financial lending and aid institutions (see box).

It is important for governments to realize, however, that most of the funds available for environmental purposes are directed at pollution control. Thus it may be necessary to convince lending institutions to alter rules in order to make cleaner production investment possible. Of course this can be

done only if the National Plan of a developing country gives high priority to cleaner production. Many international institutions, however, are becoming more interested in cleaner production.

The European Bank for Reconstruction and Development, for example, has an environmental mandate to promote environmentally sound and sustainable development. The Bank lends money or takes an equity position on a country or regional project-specific basis in Central and Eastern Europe, leaving sectoral and structural loans to the World Bank. Both private and public sector projects are sponsored. Project support can be provided for environmental policy (regulatory) formation, environmental infrastructure and services (including the environmental goods and services industry), inter-country technical cooperation, the harmonization of regulations and legislation, and sectoral studies. These studies can lead to the financing of future projects. The Bank can reject loans on the basis of environmental impact assessments and can require public participation in its loan agreements.

The World Bank, in contrast, provides government loans for projects and may require full, partial, or no environmental assessment. The Bank has produced environmental guidelines that have been used by the Global Environment Facility, a joint venture with UNEP and UNDP, to provide loans for protecting biodiversity, the ozone layer and international waters, and for limiting greenhouse gas emissions. The Bank also co-sponsored the Environmental Action Program for Central and Eastern Europe, focusing on policy

Major financial institutions with interests in cleaner production

The World Bank
The European Bank for Reconstruction and Development
The European Investment Bank
The International Finance Corporation
The International Monetary Fund
The Inter-American Development Bank
The Asia Development Bank
The Nordic Environmental Financing Corporation
The Nordic Investment Bank
The Global Environment Facility
The US Agency for International Development
The Arab Fund for Economic and Social Development

'The establishment of government assistance mechanisms to promote the export of cleaner production technologies by domestic developers would provide not only greater incentives for development, but also revenue that might be used to finance other cleaner production projects.'

reform, institutional strengthening, and investment. However, this effort relies on improvements in pollution control rather than fostering pollution prevention and cleaner production.

The US Agency for International Development supports, among other things, the World Environment Centre (founded by UNEP) to conduct studies, conferences, and training of both government officials and environmental managers of firms. It is sponsoring projects on cleaner production demonstration, training and technical assistance involving industry, government and NGOs. US AID has a major initiative called Environmental Pollution Prevention Pays (EP3) which is promoting cleaner production in several countries.

Access to the right kind of financing is, however, still a serious problem. Cleaner production assessment and capacity building should be included in all major projects involving national and international business to prevent inappropriate development in the recipient country.

Technology cooperation

Technologies can rarely be transferred without significant adaptation to developing countries. Not only are local physical conditions likely to be different, but also energy availability, labour availability and factor costs, and technical know-how will vary considerably from the donor country. Indeed, economic, social, cultural and religious factors are of immense importance in designing significant technology transfer mechanisms. Technology transfer from abroad must complement, not substitute

for or work against, beneficial changes in the domestic economy.

In order to ensure that production technologies imported into a country meet a minimum degree of environmental performance, it could be required that joint ventures or foreign-owned companies meet the same environmental controls as those encountered 'at home'. Some multinational firms, concerned with their image back home, have stated agreement with this practice and have signed the CERES Principles as an expression of their commitment. This is the practice already required by the OECD Council Acts for waste management. In the context of multilateral lending institutions, the European Bank for Reconstruction and Development requires project sponsors to follow the most stringent regulatory requirements among the partners in loans for projects. Import tariffs could be placed on products regulated in other jurisdictions, or that are otherwise deemed environmentally harmful; even import bans could be instituted. For these trade policies to work, there must be both adequate legal machinery in place and the expertise to track and assess the import of undesirable production technologies and products.

Like other economic instruments, trade policies can serve a number of other purposes: to raise revenue, protect domestic industries and to minimize foreign influence and maintain the character of a country's culture. Already existing tariffs and barriers could be relaxed in a targeted manner to encourage specific cleaner production technologies to penetrate a domestic market. Additionally, the

utilization of a percentage of profits earned by multinational corporations for cleaner production development or diffusion within the country could be required.

The establishment of government assistance mechanisms to promote the export of cleaner production technologies by domestic developers would provide not only greater incentives for development, but also revenue that might be used to finance other cleaner production projects.

While multinational corporations are likely to be significant sources of both technology transfer and financial assistance, small and

medium-sized enterprises in developed countries are playing an increasingly important role. They are responsible for 50 per cent of the environmental goods and services in the OECD countries. These goods and services, of course, include both pollution control and cleaner production. Unfortunately, many of these firms are not equipped to enter developing countries' markets nor to include a capacity-building component in their activities involving the transfer of technology. Effective transfers between North and South should be 'needs driven' and involve the participation of a wide range of potential beneficiaries in the formulation of those needs, thereby

Promoting cleaner production in China

In 1993, China's National Environmental Protection Agency (NEPA) launched a project promoting cleaner production in China. The project is being co-funded by the World Bank. UNEP plays an advisory role to both the World Bank and NEPA in the design, preparation and implementation of the project. The project seeks to show through training programmes, policy studies and recommendations, and more than 30 demonstrations at company level, that cleaner production is an important option for China.

UNEP/IE carried out three missions to China in 1993. Fifteen senior Chinese experts were trained in the cleaner production concept and the use of cleaner production assessments in seven companies. Substantial benefits have already been achieved:

- ❖ 67 changes, varying from alterations in operational procedures to modification of process equipment, were implemented without external funding;
- ❖ less than US\$16 500 was invested and resulted in a saving of more than US\$350 000; and
- ❖ more than 50 per cent of the chemical oxygen demand in the waste waters produced was eliminated.

The main results of the preparation phase were the training of Chinese experts, a Chinese version of the *Cleaner Production Audit Manual for Companies*, seven case studies and reports, an action plan for introducing cleaner production to China, and a greater awareness of cleaner production among high-level Chinese officials. The expected results from the next phase will include:

- ❖ more trained experts;
- ❖ three industry-specific *Cleaner Production Audit Manuals*;
- ❖ more company-specific reports on successfully implemented cleaner production;
- ❖ models for the dissemination of the cleaner production concept to other regions and city areas in China;
- ❖ a policy study with recommendations on how to improve existing policies and legislation to help industry in implementing cleaner production

In addition, training materials and videos will be available for Chinese trainers to use in disseminating the results of the project throughout China.



The Norway/Poland Cleaner Production Programme

The Polish Cleaner Production programme receives financial and technical assistance from Norway. A year after the programme began, participating companies were asked to complete a questionnaire in time for the first national meeting of the cleaner production movement in Poland.

This meeting was attended by representatives of more than 150 large industrial companies which have completed the cleaner production training and design programme in Poland, and which have signed the Polish declaration on cleaner production (see page 11). About 60 companies had replied to the questionnaire, which revealed that the savings achieved in the programme were already more than three times its cost.

generating a genuine ownership of the resulting actions rather than externally-imposed changes.

Aside from the provision of funds to finance technology and information development and transfer, optimal use of the experience of international organizations and agencies can also facilitate cleaner production. The OECD Environment and Development Cooperation Directorates, the United Nations Environment Program (UNEP), the United Nations Development Programme (UNDP), the United Nations Industrial Development Organization (UNIDO) and the Commission on Sustainable Development (CSD) are rich sources of ideas and policy options.⁹ Access to these institutions is easy and can provide perspective on constructing the appropriate benchmarks against which to evaluate potential projects financed by the lending and aid institutions.

The box on page 27 provides details of a major cleaner production project in China

that has been organized and financed through international organizations. This project is expected to bring cleaner production within five years to more than 3000 Chinese enterprises which are the main sources of pollution in China. As already mentioned, a number of international organizations are also cooperating to assist in the development of national cleaner production centres.

The box on the left gives details of another internationally-funded programme: the Norway/Poland cleaner production programme.

CONCLUSIONS

Implementing cleaner production requires both willingness and capacity on the part of government and industry to bring about a transformation of their national economies. This transformation may involve both incremental and more radical changes, require careful targeting, staging and phasing-in of different policies and initiatives, and changes in the roles of various stakeholders throughout the transition to a cleaner production economy. Critical to the success of a cleaner production strategy are:

- ❖ a shared vision of how to promote cleaner production—'start small but think big';
- ❖ a consensus that the best way forward is through cleaner production;
- ❖ an assessment of existing policies, followed by corrective action;
- ❖ a series of cleaner production initiatives such as demonstration projects; and
- ❖ long-term finance and technical assistance.

These essential elements are illustrated in the diagram on page 11.

The first steps are to develop a shared vision and consensus, and to establish a proper climate for financial and technical assistance from both national and foreign institutions to facilitate cleaner production. They must be followed up by the specific strategies and policy instruments that have been discussed in this document. The choice and implementation of specific measures in a particular country must be individually fashioned. No one formula will apply. The OECD countries are themselves still experimenting with appropriate strategies and policies, and future editions of this publication will be produced to report on these developments, as well as on the successes (and failures) of attempts to catalyse the adoption of cleaner production in developing countries and in countries undergoing economic transition.

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APPENDIX

Participants in the UNEP/IE and OECD Workshop on Policies to Promote Cleaner Production in Developing Countries and Countries in Transition Paris, 7-8 June 1993

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