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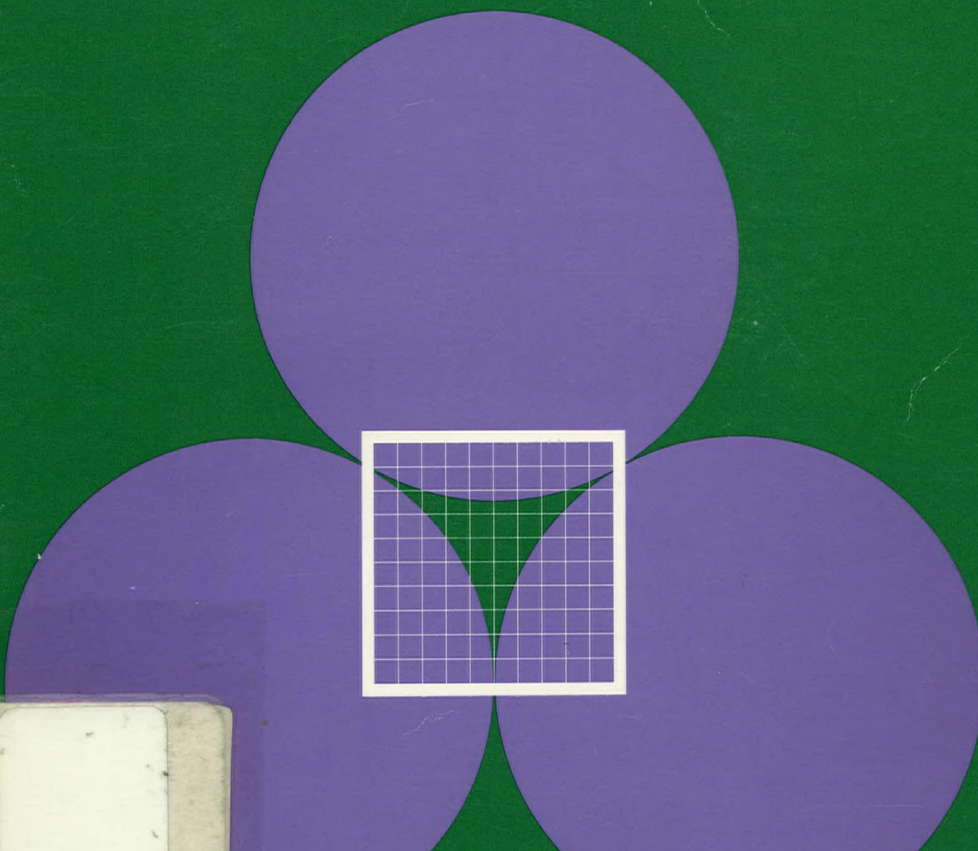
Task Force on Environmental Protection Technologies

Report to the Minister of State for Science and Technology



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Report
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TABLE OF CONTENTS

FOREWARD

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EXECUTIVE SUMMARY

The Task Force on Environmental Protection Technologies was established by the Minister of State for Science and Technology to advise the federal government on how Canada could reap economic benefits from technology development in this area. It found that the development and use of innovative technologies to solve environmental problems holds potential for contributing to Canada's economic growth. New technologies can represent less costly alternatives to traditional control methods thereby benefiting those who use them; furthermore, the installation of such technologies at home or abroad can provide earnings for those who manufacture or service them. By solving problems at home, Canadians can develop skills, expertise and equipment that can also be sold abroad. In this way environmental problems in Canada can be seen as opportunities for technology development.

The most promising opportunities identified by the Task Force are related to the development of monitoring and sensing equipment, remote data gathering, automated control technologies, and pollution control equipment adapted to solve the environmental problems associated with resource development in frontier regions.

As well as these present equipment development opportunities, new processes to manage municipal waste waters and solid waste represent future opportunities. In the long run, to control environmental damage resulting from industrial activities, basic processes will need to be redesigned. This is a difficult and costly process,

but can hold great benefits. Finally, such developments will enhance opportunities for Canadian firms who draw on their expertise at home to compete in the environmental engineering market internationally.

Other opportunities may be found as a result of research aimed at solving what are at present intractable environmental problems. For such problems research will be the dominant activity today, in contrast to the more immediate opportunities which now require an emphasis on development and marketing. Areas where research today may lead to long term economic opportunities include hazardous waste management, control of noxious odours and noise, and minimizing the effects of acidic deposition.

The environmental protection equipment industry is a modest part of Canada's economy today, and the market for environmental goods and services will likely remain small compared to other activities. However, it is an area where Canada has definite needs and where Canada can profit from innovation. An important action to promote this would be to minimize the factors identified in this report which now impede that innovation. Some of these factors are particular to the field. Environmental protection is usually only one concern among many for those incorporating it. Typically, only 10 to 15% of the cost of a major new facility is allocated to environmental protection and as a result it is seldom the centre of attention for technical innovation. As well, certain aspects of the regulatory process also contribute to a conservatism which perpetuates the use of existing well demonstrated technologies and discourages the development and use of new unproven technologies.

In Canada today the structure of the pollution control industry also tends to frustrate the development and use of new technologies: manufacturers are small, often subsidiaries of foreign companies which do little development work in Canada. In some cases, such as the treatment of toxic substances and disposal of solid wastes, social attitudes (such as the demand for risk free solutions) forestall the use of new technologies. Finally, the preferred solution to environmental problems faces further impediments. This solution involves a major change in basic processes to avoid creating environmental problems. However, such changes are risky and costly and so reluctantly undertaken.

While several different types of incentives are currently offered to stimulate innovation, these do not provide sufficient encouragement for the needed research, development and demonstration to allow Canada to benefit from the development of environmental protection technologies. The major need is assistance for prototype installations.

The Task Force recommends that action be taken by the federal government to minimize the effects of the impediments to innovation, and to provide financial assistance targeted at the development of environmental protection technologies. Sharing the risks of introducing innovative technologies and minimizing regulatory impediments are among the recommended actions. This combination of non-financial and financial initiatives would lead to greater innovation in environmental protection technologies and allow Canada to benefit from the opportunities in this area.

1. INTRODUCTION

In August 1981 the Honourable John Roberts, Minister of State for Science and Technology and Minister of the Environment, established the Task Force on Environmental Protection Technologies.

He asked the Task Force to consider what economic benefits could accrue to Canada through the development and use of environmental protection technologies. The public announcement of the Task Force emphasized the importance of environmental protection technologies to the optimal economic exploitation of Canada's natural resources and also stressed the need for Canada to make an early start on the development of these emerging technologies in order to take advantage of the opportunities offered by a world-wide market.

1.1 Terms of Reference

The terms of reference for the Task Force are:

1. to identify the most promising commercially applicable opportunities in environmental protection technology and the development of "non-polluting" processes

2. to explore the most appropriate means for developing these opportunities to commercial viability

3. to determine the best means for disseminating and exploiting these technologies.

1.2 Background

Canada is a northern country, large parts of which experience long, cold winters.

Under such conditions biological and chemical processes take place slowly, so that recovery from ecologically disruptive actions is protracted. As well, this slow change may delay the emergence of the effects until long after the action which caused them. Many environmental protection measures have been developed and used in regions with warmer temperatures. Often, they do not work nearly as well in the Canadian setting. For example, the accepted procedure for handling a spill of vinyl chloride was developed in the U.S.A. It assumes that the substance will evaporate and disperse when spilled. However, when a train derailment caused a spill of vinyl chloride monomer in Manitoba in winter, it remained a liquid and new clean-up techniques had to be developed on the spot.

As the search for petroleum and other resources in the far north leads to further development, the problems of environmental management in harsh winter climates will become increasingly important in Canada. Disposal of wastes, both domestic and industrial, will require solutions appropriate to such harsh conditions.

In that part of Canada which is unsuitable for agriculture, forestry is important and widespread, and rich mineral deposits have also been extensively developed. As well, the rugged landscape has important recreational uses. Such uses of the land are threatened by the fact that a significant part of Canada is vulnerable to the effects of acidic deposition. This problem is not unique to Canada — similar pollution of sensitive regions occurs in the U.S.A., Scandinavia and Central Europe.

Canada's emphasis on resource exploitation has resulted in the development of Canadian technologies for these industries. Canadian processes and technologies in mining, agriculture, fisheries, smelting, metal refining, forestry and pulp and paper, both hydro and nuclear electricity generation, and long distance transmission and distribution of electricity are acknowledged as among the best in the world and are widely used in other countries. Canadian consulting firms with expertise in these resource-based activities service a world-wide clientele.

Canada's resource development has at the same time given rise to, and limited the opportunities for, the development of environmental protection technologies. Resource industries pose significant threats to the environment. Some examples of environmental problems associated with particular industries include: aesthetic problems and water quality degradation with the pulp and paper industry; acid drainage and toxic chemical releases (eg. heavy metals, asbestos, radionuclides) with metal mining and the subsequent smelting; release of oxides of sulfur with smelting and of oxides of sulfur and nitrogen with thermal power generation; disruption of wild life habitat with oil and gas exploration; and degradation of water quality with chemical or petrochemical production, food processing, and agricultural practices. At the same time many of these resource industries themselves depend upon a certain environmental quality and can be adversely affected when baseline conditions degrade. The interruption of a portion of the commercial Great Lakes fishing industry due to mercury uptake from chemical industry discharges provides one example of such interdependencies.

Canadians are resolving these conflicts by solving environmental problems. Out of this technology development opportunities arise. Hence, our environmental *problems* can be seen as *opportunities* for the development, demonstration and use of environmental protection technologies.

In other fields, such as in communications and electronics, Canada has developed significant technological strengths. Expertise in these areas will also help to define new opportunities since our future progress will result from building on our present strengths. By developing and promoting technologies in Canada to solve Canadian problems we may be able to promote exports to other countries that share similar problems. This should lead to significant opportunities since many countries around the world wish to exploit their natural resources without causing significant environmental damage, and so are looking for environmentally appropriate ways to develop natural resources.

1.3 Approach

To attempt to identify as many opportunities as possible, a broad definition of environmental protection technologies was adopted. The environment is a resource to be used. To provide for its continued and expanded use, the environment must also be protected. Environmental protection technologies are employed in many different activities. They include assessment of the state of the environment before a development is begun, planning developments to minimize environmental disruption or damage, monitoring, replacing damaging processes with less harmful ones, developing techniques to capture or prevent the release of harmful substances, safely disposing of wastes, training operators of pollution control facilities.

The Task Force drew on the experience of many in the environmental protection field. At its first meeting, it decided to contact companies, universities, agencies and individuals on the many different aspects of this field. As well, the Task Force and its objectives were publicized in the popular and technical press so that the pollution control community in Canada could participate in its work.

Written comments sent to the Task Force often were followed by more detailed discussion. The Task Force or its individual members also met with representatives of industrial associations, public interest groups, consultants, manufacturers and users of environmental protection equipment, and held discussions with federal government officials from the Department of the Environment and the Department of Industry, Trade and Commerce. A list of those who presented written comments to the Task Force is included in Appendix A.

Early in its work the Task Force considered its terms of reference, and its limitations in time and resources. It decided to concentrate on identifying the major problems which held back innovation in environmental protection technologies and recommending actions to improve innovation in this field. The Task Force has, also, identified broad areas within which it expects there are opportunities for commercial development. It did not try to compile a comprehensive detailed list of "promising opportunities". Furthermore, it doubted that an attempt to assess the relative merits of the individual specific technological "opportunities" of such a list would have provided meaningful information, given the limitations of the project.

The opportunities are reviewed in Chapter 2. There is also some discussion of what actions (demonstration, further development, or research) may be needed. The expected market for such technologies is discussed in Chapter 3. Commercialization of environmental protection technologies will require a climate that favours development and use of innovative technologies. To improve this climate, existing impediments to innovation must be identified and removed. These impediments are discussed in Chapter 4. Existing support programs designed to assist research and development are described in Chapter 5. Chapter 6 presents some proposals. The conclusions of the Task Force and its recommendations are summarized in Chapter 7.

2. AREAS OF OPPORTUNITY

Opportunities to exploit environmental protection technologies can be found in existing innovative technologies and also in the very problems that have not yet yielded to technical solutions. The first category includes ideas or processes that have emerged from the laboratory but have not yet become commercially successful, that is, new, unproven and unexploited technologies. An emphasis on development, demonstration and marketing (activities to meet the economic, as well as technical obstacles), are required to commercialize technologies that have been brought from the laboratory to pilot scale. The second category includes gaps in existing technologies which would represent opportunities for the development of new technologies, in other words, problems which are not satisfactorily handled with existing technology. Today, research is the most important activity in this area.

A number of factors such as urgency of the environmental problem, potential market, likelihood of success, and economic impact of the environmental protection technology (contribution to the GNP, jobs, possible spin-off, etc.) were considered in the identification of opportunities.

2.1 Promising Technology Areas

Opportunities for both the domestic and export markets arise from existing unused or underused technologies. Included are equipment, process technology, and consulting and engineering services. For each of these there are different scales of economic benefits and different degrees of difficulty in realizing them.

2.1.1 Equipment

Canada has already proven its competence in developing and marketing environmental protection equipment. For example, the reciprocal-flow ion-exchange device used to recover valuable metals previously lost in rinse waters from metal plating operations, which was developed at a Canadian university in the 1960's, became operational in the 70's and since has been successfully marketed internationally.

Canada's expertise in electronics and communications has led to recognized competence in the design and manufacture of monitoring and sensing equipment. A Canadian electro-optical sensing unit for remotely sensing concentrations in the atmosphere of oxides of sulfur and nitrogen is being successfully marketed around the world, and is being used to monitor transboundary air pollution. Canadian firms have also developed technologies used to analyse, monitor and control sulfur emissions and participate in the international market for these goods and services.

Canada shares with other countries specific needs for monitoring equipment to measure gases and aerosols, radionuclides, toxic substances and other substances considered a risk to man or the environment. The growing emphasis on the need for careful documentation of such hazards will create a demand for sensitive measuring equipment that could be produced in Canada.

Canada's efforts in remote sensing also suggest that there may be opportunities for the development of remote sensing systems to be used to detect and observe forest damage and environmental emergencies such as oil spills.

More generally, the engineering, as well as the subsequent operation of major industrial enterprises, or of large municipal waste treatment facilities, require information on environmental parameters. Continuous monitoring of meteorological variables such as wind speed and direction, and conditions of atmospheric mixing is now often used to control a number of contributions to the pollution problem to accommodate both environmental and economic concerns. When particular atmospheric conditions, such as an inversion, demand that emissions be reduced, different fuels can be used or operations reduced. Such regional monitoring systems are used to serve as supplementary controls during adverse environmental conditions.

Canada faces particular problems in gathering needed environmental data from remote locations. Data gathering systems with the capability of transmitting observations to a central receiving location may represent significant opportunities. Such developments would bring our competence in electronics and communications to bear on the solution of environmental problems. Development in frontier regions will require monitoring of meteorological and marine variables (temperatures, wind speed and direction, currents, ice thickness, etc.) and specialized observation of wildlife location and behaviour patterns, migratory routes and so on.

Automated control technologies employed to optimize industrial processes represent another area of opportunity. Such systems require both sensors to monitor important parameters of the process and a feedback system which makes adjustments to control the process. These technologies are often based on digital control and incorporate microprocessors. The recently introduced microprocessor control of the automobile engine illustrates the advantages of such technologies.

Similar approaches can be used to optimize environmental control processes. By monitoring dissolved oxygen and controlling the rate of oxygen injection, significant energy savings can be realized in conventional biological wastewater treatment. Furthermore, this also leads to improved overall operation and improved effluent quality.

The development of such process control equipment components could be linked with ongoing R&D efforts in process control systems and could build on Canada's progress in micro-electronics and robotics. They would have direct application in Canada and have the potential of world-wide sales. As well, similar sensors and control units can often be used for different applications, leading to larger markets for the devices. A logical place to begin this work, because of the significant domestic market, would be the improved control of municipal wastewater treatment. This will be discussed in more detail in the next section.

The growing emphasis on resource exploration in frontier regions indicates further opportunities for equipment development. In particular, the potential for oil spills calls for new equipment to identify, control, and clean up such spills. Canadians have already developed and sold skimmers for cleaning up marine oil spills. The increasing exploration in the North and offshore Newfoundland involves pioneering in oil and gas development in ice-covered or ice-infested waters. Techniques and equipment for dealing with spills in cold climates and in the presence of ice are only now being developed and commercial opportunities for equipment production may be found here also.

The previous examples have emphasized small, relatively sophisticated devices that can be manufactured in Canada and exported. Unfortunately, there are significant limits to the amount of economic benefit to Canada which could result from the development and export of *conventional* pollution control equipment. Such equipment is large, bulky and usually constructed on-site from locally available materials. Clarifiers and digestors used in wastewater treatment are examples, but even electrostatic precipitators and baghouses used in the control of particulates in emissions are also, in large part, fabricated locally. In many cases only the know-how and design (such as a detailed set of drawings backed up by advice on construction, start-up and operation) can be marketed.

2.1.2 Pollution Control Processes

The basic processes used for removing many pollutants from waste emissions have been developed long enough ago that patent protection of refinements is not very secure. More importantly, the actual installation of a new pollution control system uses a great deal of equipment not unique to the process. Such materials are purchased or constructed on-site. While the installation of such systems in Canada would have economic benefits, the chief export potential would centre on consulting engineering services.

Ongoing Canadian research concerning wastewater treatment may lead to commercially applicable technologies allowing more effective biological removal of nutrients from municipal wastewater. Chemical processes are now used to remove phosphorus from municipal wastewater in several provinces. Biological removal of nutrients is a well demonstrated technique in warmer climates and could represent a more cost effective alternative here. Successfully adapting this process to meet our own needs may also lead to exports to countries with similar climates.

Sewage systems which use less water than conventional systems could offer opportunities particularly for applications in developing areas, in Canada and elsewhere, where there is no existing sewage collection infrastructure. The concentrated wastewater of such systems might be better suited to biological treatment using anaerobic processes, a desirable treatment method which requires less energy, produces an energy source, methane, and results in a smaller final volume of sludge, thereby simplifying ultimate disposal.

Improvements to anaerobic processes may present additional opportunities for the treatment of other high strength waste streams. Conventional aerobic sewage treatment produces sludge which typically contains 95-98% water. Usually the sludge is dewatered and incinerated or digested anaerobically. Each of these alternatives has drawbacks. Incineration is costly because the water is difficult to remove mechanically and is usually evaporated. Present anaerobic digestion is not very satisfactory since the sludge must be treated for a long time and the digestors are difficult to control and are frequently upset. Research now underway in Canada shows promise of significantly reducing the sludge holding time and also improving the reliability of anaerobic digestors. The potential savings in both capital and operating costs are very significant.

2.1.3 Waste as a Resource

Finding uses for wastes presents economic advantages. Income may be gained from previously discarded materials, as well, treatment and disposal costs may be reduced. Recycling as a concept is not new. Historically, the ruins of one culture's buildings often supplied the construction materials for those of the next. More recently, the paper industry in North America began by using waste materials (rags). When demand outgrew supply substitutes were sought, and wood came to be used as a raw material. Metals such as iron, copper and aluminum, and glass and paper are now routinely recycled. Industries based on the use of these materials have waxed and waned as the economics have changed. This concept is now being extended to include the recycling of exotic wastes which may be costly to dispose of or treat. An exchange service which attempts to pair industries with such wastes to industries that would be able to use the waste as a raw material has already been initiated. There should be opportunities both for the extension of such systems, and for equipment and processes that allow more wastes to be more extensively re-used.

There are also opportunities related to the improved management of solid wastes to replace conventional land fill disposal practices. The increased cost of transportation and of land fill sites has prompted serious examination of alternatives such as recycling, and incineration. Separation at source could lead to reclamation of recoverable and reuseable materials. Incineration can offer an energy return. Many of the hurdles to be overcome in applying such alternatives are not technical, but rather economic, social, institutional and political. A combination of recycling and incineration may make centralized recycling and processing of solid wastes more economic, and more widely used if the non-technical impediments (including public acceptance) are overcome.

2.1.4 Industrial Processes

In principle, the redesign or replacement of a polluting process is much preferred to the incorporation of add-on devices which usually lower overall efficiency of the process and require an added investment that does not produce any increase in output. Early automobile pollution control devices which increased fuel consumption are one example of the problems with add-on devices.

To limit sulfur emissions, redesign has included the replacement of existing smelting technologies with processes that generate concentrations of sulphur dioxide off-gas suitable for conversion to commercial grade sulphuric acid or liquid sulphur dioxide. Another example of redesign has been the well-head cleaning of sour gas to remove sulfur from natural gas before the fuel is transmitted to its users. Several Canadian firms conduct research in these areas, have developed new innovative technologies that are sold world-wide, and can be expected to continue developing new processes.

Redesign of industrial processes can be even more fundamental and at times entirely different processes may be used to provide the needed goods or service. Coal burning thermal power plants which produce sulfur dioxide can be replaced with hydro-electric or nuclear facilities. However, as discussed in Chapter 4, the more fundamental the change, the more wide-reaching are its implications. As a result, fundamental changes are much more difficult to bring about than incremental changes.

2.1.5 Services

Regardless of the scale or scope of environmental protection technologies, all include a service component which can consist of the provision of technical know-how in the design, construction, operation and maintenance of the process. Environmental services that may also be required for major undertakings include conducting environmental baseline studies and preparation of the attendant impact assessment statements, and the subsequent monitoring to ensure ongoing environmental quality.

Canadian firms successfully compete world-wide to provide the design and construction of resource developments such as mines, smelters, petrochemical, pulp and paper installations, and thermal, nuclear and hydro-electric power plants. Environmental protection design is now an increasingly important component of these proposals, a fact illustrated by the recent partnerships of major general engineering and environmental consulting firms. Canadian firms are able to draw on their experience in Canada to solve the environmental problems associated with resource developments and to sell this technical expertise to other countries.

Another service activity pertains to specific environmental control measures such as designing waste treatment facilities, advising on their operation or providing advice to firms on solutions to environmental problems. Specialized advice also includes consulting with governments on the design of their environmental protection organizations, the development of regulations and more generally on environmental policy.

Training represents another limited opportunity area where Canadians are already active in a growing market. A packaged audio-visual program for training the operators of municipal wastewater treatment facilities is used across Canada and has been sold to other countries. As well, Canadian consultants are engaged to train personnel in the operation and maintenance of waste treatment facilities in other countries.

2.2 Technology Gaps — Research and Development Opportunities

Some important environmental problems have no adequate cost-effective technological solutions. In these areas the priority should be increased research aimed at the identification of more promising alternatives.

Such research can range from developing a cost-effective method of removing trace organics from drinking water on a large scale, to exploring new methods of recovering the valuable organic material from fish plant wastes.

Research will continue to be needed to find effective and socially acceptable methods to dispose of hazardous wastes including both nuclear and non-nuclear toxic wastes.

The prominence of "acid-rain" as an environmental concern directs our attention to gaps in the available technologies for the control of acidic gases, the oxides of sulfur and nitrogen. Many technical solutions have been proposed, but the lack of their widespread implementation suggests that more cost-effective technologies continue to be needed.

Odours are difficult air pollution problems which also require new cost-effective technological solutions. Examples of odour problems include odorous sulfur compounds associated with kraft pulping operations and refineries, and odours released from slaughterhouses, meat packing, fish processing, rendering, and sewage treatment plants.

To combat the harmful effects of noise, development of quieter machinery or improved noise abatement technology can be expected. As with the earlier discussion on process change affecting other polluting processes, a redesign which avoided the production of noise would be preferred to add-on facilities designed to reduce the effect of the noise.

Finally, a particular need exists for small, simple to operate sensors that could measure human exposure to concentrations of hazardous substances in the workplace. Simple personal dosimeters that could be worn by employees in a manner analogous to the radiation dosimeter used by those in contact with radioactive materials would find a large market.

3. MARKETS

Quantitative assessments of the market for environmental protection technologies are difficult. An earlier study* estimated the pollution control equipment market in Canada to be about $370 million in 1978. The largest component of this market was related to water and wastewater treatment, and the largest purchaser was government.

In total about 42% of the Canadian market was met by imported products, many of which could be produced in Canada. Exports of equipment were very small and usually resulted from branch plants supplying specific equipment to their parent. The study concluded that there was a potential for expanding the market for Canadian produced equipment through import substitution in categories such as pumps, blowers, filters, valves, piping, and instrumentation.

The environmental equipment business in Canada remains small — the activity of small parts of major corporations, or of small assembly or sales companies. There may be opportunities for Canadian manufacturers to displace imports or to export, but the structure of the industry limits these opportunities.

In Canada, environmental protection firms are usually engaged in consulting, engineering, or marketing of imported equipment. Few conform to the manufacturing model of a firm which carries out research, develops products, manufactures and markets them. One exception appears to

*"Potential for Expansion of the Pollution Control Industry", Government of Ontario, 1979

be firms active in the instrumentation/ monitoring equipment field. Most of the rest are concerned with only a small part of this spectrum of activities and indeed some of the manufacturers are based on a particular product or a very limited product line.

The Task Force adopted a broader definition of environmental protection than that used for the Government of Ontario study. As a result the potential market for "environmental protection" technologies discussed will be larger than that identified in the earlier report. Even so, the 'technological' component of investment in environmental protection is very difficult to estimate. Although figures such as 5% to 15% of the capital costs of a major new facility (mine, mill, factory, etc.), are attributed to environmental protection facilities, the estimates can be misleading. Large parts of these expenses are devoted to construction — excavation, earth moving, concrete, steel, etc., and much of the equipment used is neither designed nor employed exclusively for pollution control. In addition, while pollution control activities may lead to particular economic benefits, such as jobs in manufacturing, these benefits can not be uniquely linked to a "pollution control industry"

Services such as engineering design represent an important part of environmental protection activities. Indeed, given the nature of environmental protection equipment and processes, and the present structure of the environmental protection industry in Canada, it is likely that the major opportunities in the export market are for these services. Canadian consulting engineering firms and environmental consultants already compete successfully in the international market, and this is expected to continue to be one of the ways of taking advantage of experience gained in Canada.

4. IMPEDIMENTS TO INNOVATION

Removing or minimizing the blocks to innovation are the most effective activities the federal government could take to assist the development of environmental protection technologies. Two impediments unique to the environmental protection field were identified: the nature of the activities themselves, and the effects of regulations.

Environmental protection, by its nature, traditionally has been peripheral to the basic thrust of most commercial activities. Decision makers in manufacturing operations are often reluctant to use new innovative (and occasionally commercially unproven) techniques especially in these "peripheral" areas. This reluctance to incorporate innovations is shared by all concerned — manufacturers, consultants, designers, users and regulators. Whether designing a new facility or adding new control equipment, there is generally a tendency to use well established methodology for potential environmental problems rather than risk delaying or damaging the entire project by incorporating techniques which lack a proven record.

Similar tendencies to conservatism in technology selection may be found in other areas such as municipal waste treatment, and this conservatism may be reinforced, or created, by the regulatory process. Protecting the environment is a social and political goal, and the chief mechanism used has been regulation with penalties. The threat of the penalties leads to caution in the selection of technologies for environmental protection.

At times the very process of developing regulations can solidify the choice of a control technology and inhibit the development of new technologies. This "Catch-22" results from the emphasis on "best practicable technologies" in establishing regulations. Regulations based on what is technically and economically practicable will obviously reflect existing technology. If there are no specific incentives to do more than "meet the regulations" technology development can stagnate.

These problems are compounded where the approval process (for proposed pollution control) stipulates in detail how the control is to be achieved rather than stipulating the allowable discharge.

The guidelines and regulations established by the provincial agencies regulating construction of wastewater treatment facilities have a very great effect on the type of technology used. The prevalent selection process of favouring well proven systems discourages innovation. Here, as in the industrial case, the legitimate concern of reliability acts to inhibit the commercialization of new technologies.

The history of the "closed-cycle" pulp mill (using the Rapson-Reeve process) illustrates additional impediments faced by innovations which make fundamental changes and shows how they were overcome. This new process allows bleaching effluent to be processed in the recovery boiler that has traditionally been used to recover only the spent pulping liquor of the kraft process. This allows recovery of almost all effluent within the mill.

A company was sufficiently daring to try out an unproven process in a new mill it was constructing to parallel an existing operation; it was supported by the federal government through the Development and Demonstration of Pollution Abatement Technology Program (DPAT). Anticipating success with this innovative process, the company also made a commitment to the provincial environmental authority to modify their existing plant to permit a similar system to be incorporated rather than instal a conventional system. However, technical problems arose which were not resolved before the deadline for installation of equipment to treat effluent from the existing mill approached. The company therefore applied to the Ministry of the Environment for approval to use a conventional biological treatment process (aerated lagoons). At the public hearings necessary to approve such a change, residents of the area near the proposed lagoons objected.

Also, the regulatory authorities realized that sticking to rigid deadlines for selection and implementation of an effluent treatment system might prejudice the entire attempt to prove out the new technology. Accordingly, they extended the time limits in the control orders. A new timetable was negotiated with the company which allowed sufficient time to solve the technical problems which had arisen with the closed cycle concept. As a result the new closed cycle recovery of the bleaching and pulping effluents will be used in both the new and existing mills.

There are additional blocks to innovation in this area. The majority of pollution control equipment manufacturers are small companies that do little R&D and have a limited product line. A research organization, not directly associated with a manufacturing facility, that tries to commercialize an innovative technology, often has difficulty finding a firm to manufacture the product. Industrial associations and research institutes which have carried projects through to the development of prototypes have reported difficulty in finding a company to manufacture and market worthwhile products with a limited market.

The small size of most pollution control equipment manufacturers causes other difficulties. Potential buyers usually want a guarantee, or an agreement to remove the equipment if it cannot meet specifications after it is installed. Small firms rarely have the financial resources to provide such guarantees, or to absorb the cost of removing the equipment and restoring the client's facility.

Finally, although industries with waste control problems carry out a considerable amount of research and development aimed at solving them, only occasionally does such research lead to a product or process which is marketed by its developer. Occasionally, large companies develop pollution control equipment to meet their own needs, manufacture it for internal use and also market it. Such activity is very much the exception, however.

Company ownership can affect both the participation in developing new technologies and the realization of the benefits of such development in Canada. As noted earlier, many of the firms marketing environtmental equipment in Canada are subsidiaries of foreign firms supplying technology developed outside of Canada. Some of these multinational firms hold patent and licensing rights for all developments of their subsidiaries within the parent company. This fact supports the conclusion that simply encouraging increased research spending in Canada will not necessarily produce the economic benefits expected from research, development and innovation.

Innovation in environmental protection technologies can also be hindered by social attitudes, such as the "not-in-my-backyard" syndrome which prevents the establishment of new waste treatment or disposal facilities. Although there is a clear need for treatment and disposal of toxic wastes, people living near proposed sites distrust the developers and operators of the facility. They are concerned about their own safety and deteriorating property values. Technology exists to manage the complex waste products of modern society. Technical experts are convinced, for example, that there are, at present, good, effective technologies to destroy PCB's (polychlorinated biphenyls). However, municipal governments, reacting to citizen opposition, will not allow such a facility to be established in their neighbourhood. This reaction is so universal that the technology is not being used anywhere in Canada. Stocks of PCB's and other toxic waste products continue to accumulate in temporary storage. These emotionally laden concerns must be resolved so that innovative waste-treatment technologies can be implemented.

Finally, further obstacles impede the introduction of the best solution to environmental problems. In principle, a fundamental change in any industrial process which removes the need for add-on control facilities would be preferred. However, this has such a wide range of investment and other implications that it only rarely occurs.

For example, the pulp and paper industry over the next few years will be considering the possibility of fundamental change to the chemical recovery process associated with kraft pulping. Several new processes are under consideration. One of these would be appropriate to the kraft pulping of hardwoods if anthraquinone were used as the pulping chemical additive to replace the sulfur compounds currently in use. It would then be possible to use a less complex chemical recovery system which would be essentially odour free, safer, and simpler to operate. The process appears to be viable but it has not been tested on a plant scale. Full scale testing would require either extensive changes to existing plant, or a new facility. Since the cost of a completely new (or 'greenfield') pulp mill now approaches $400 million it is easy to see why companies are reluctant to invest in a new plant based on an untried process.

On the other hand, progressive incremental advances in thermo-mechanical and chemi-thermo-mechanical pulping made over the last decade, which resulted from the R&D efforts of a number of different companies, have been more easily introduced. This underscores the conclusion that fundamental changes in mature industries are extremely difficult to bring about.

The bias against the new and unproven can be overcome through support of demonstration installations. At the same time, flexibility should be shown by regulatory agencies to avoid discouraging innovative processes which can have longer term benefits.

5. PRESENT SUPPORT PROGRAMS

Government programs at both the federal and provincial levels have been established to assist the development of technologies. Since the Minister of State for Science and Technology established the Task Force, its comments are particularly directed to the federal government. However, the cooperation of other levels of government is also important.

Certain programs encourage research and development generally. Included among these are provisions that allow companies to claim increased tax write-offs for additional spending on research and development. Researchers in the universities are able to obtain grants from the federally funded Natural Sciences and Engineering Research Council. Federal government programs that can be used to assist with the development of new technologies, applicable to environmental protection, are listed in Appendix B. None of those programs specifically encourage innovation in environmental protection technologies.

Many of the people who communicated with the Task Force spoke favourably of two former programs which were directed at environmental research, development and demonstration: Cooperative Pollution Abatement Research (CPAR) and the Development and Demonstration of Pollution Abatement Technology (DPAT).

The CPAR program provided 100% funding for research in the field of pulp and paper pollution abatement and was administered through a joint government-industry committee. It was directed at the pulp and paper industry since that was the only industry being federally regulated when the program was established. Review of proposals by a joint government-industry committee ensured the participation of industrial experts. CPAR funding was $1.25 million in its last year.

The DPAT program provided up to 50% of the estimated cost of investment in full scale demonstration of first of a kind pollution abatement technology in any industrial sector. During its operation, DPAT had provided about $2.0 million per year.

Both of these programs were quite successful. CPAR always attracted more proposals than it could fund, and both encouraged significant innovations in environmental protection technology.

When CPAR and DPAT were cancelled in 1978 the Enterprise Development Program (EDP) became the chief federal assistance program for innovation in pollution abatement. Since EDP originally had been established with quite different objectives and criteria, its terms of reference were modified to try to meet the new responsibilities. Even with the modifications, EDP has not been successful in providing assistance to environmental protection technology development. EDP limits the government's support to 50% of the approved project cost, and some of the funds must be paid back if the project succeeds commercially. Only taxable corporations are eligible for assistance. Even more difficult, the proposed development must pose a "significant burden" to the proponent. These criteria tend to disqualify environmental protection innovations which are often a small part of a firm's operation. Exceptions can be allowed to the significant burden criterion but only by approval of the Cabinet. This has led to a very long and cumbersome approvals mechanism, resulting in very little support for environmental protection research and development or demonstration projects in the last few years. Thus EDP is not well suited to supporting the development of environmental protection technologies, even in its modified form.

The federal government also carries out in-house R&D that can assist in the development and use of innovative technologies. Federal efforts are strongest in water pollution control, possibly because of the clearer federal jurisdiction. Technology development in air pollution control appears to be lacking. The Department of the Environment should promote the development of new air pollution technologies to parallel the activities in water pollution control development.

Success in achieving work abroad is often dependent on financing packages. CIDA and EDC financing of overseas work produces a market for Canadian engineering services and Canadian manufacturers. In addition, federal government trade assistance programs provide advice and aid to Canadians in exporting goods and services.

6. SOME PROPOSALS

The commercialization of environmental protection technologies is influenced by many participants at different stages of the process. The Task Force has concluded that the important blocks to the innovation process often occur after the initial research is performed, during the development, demonstration or marketing stages. Action at each of these crucial stages to improve the rate of commercialization of new environmental technologies will lead inevitably to more industrial R&D.

However, simply increasing the intensity of research activities will not lead directly to higher rates of innovation unless some of the impediments hampering the process are removed or minimized. In other words, well chosen projects undertaken by competent researchers can certainly lead to scientific advances, but these can only be turned into technological advances when there are effective mechanisms to carry the results of that research through to commercialization.

Action by the federal government alone will not remove all impediments. However, strong federal government action can motivate the other sectors to participate in the needed improvement of the innovation process. A number of changes to policies and funding arrangements which could assist the commercialization of environmental protection technologies are described below. The Task Force has selected those which it believes to be the most productive; they are listed in Chapter 7, *Conclusions and Recommendations*.

6.1 Non-financial Initiatives

a. Government Purchasing Policy

Since governments are large purchasers of environmental protection equipment, policies which encourage purchases of promising innovative technologies by government could greatly help commercialize new technologies in the municipal waste treatment area. The federal government could help by

i. using innovative technologies to meet its own environmental protection needs (such as for federal facilities and in the Territories).

ii. fostering the use of such technologies in areas where it has clear regulatory authority.

iii. encouraging other governments to use innovative technologies for environmental protection where this is appropriate.

b. Regulations

While not generally applicable, progressive environmental regulations which are introduced in a phased program over a period of time can (as was the case with automobiles) promote the development and use of new technologies. By announcing that further control must be incorporated by a certain date, this system encourages those affected to find cost-effective ways of obtaining this control, and encourages potential manufacturers of equipment which may offer the greater control by creating a future market. However, this approach is most effectively applied to control of wastes produced by frequently replaced devices (such as automobiles, mobile engines, etc.) where the new technologies can be incorporated into future models, and is more easily applied when there is rapid obsolescence in equipment or processes.

c. More Flexible Regulations

Certain approaches to regulation discourage the use of new technologies. This occurs when prescribed standards are too closely tied to existing technologies. A more flexible regulatory process which stresses the required performance of environmental protection measures rather than prescribing particular methods could be used. As well, flexible schedules for meeting new control requirements, which allows for the time to prove out new technologies, would help encourage development and use of new technologies.

d. Identification of Emerging Technology Needs

There is an extensive monitoring effort, by governments, aimed at measuring changes in Canada's environment. Less emphasis appears to be given to analysing and interpreting these data, making it is more difficult to identify developing problem areas. As well, more could be done by governments to disseminate reviews of the international scientific literature (especially that published in languages other than English or French) to help Canadians learn from the experiences of other countries and so anticipate problems which are beginning here. Both of these activities could help governments identify the most important issues in environmental degradation so as to anticipate future needs for environmental protection technologies and so encourage researchers to develop the needed technologies.

e. The Jurisdictional Issue

The shared jurisdiction between different levels of government complicates environmental protection technology development. Different regulations in different regions fragment the market for environmental control technologies. Attempts to solve these jurisdictional differences can only come through consultation and cooperation.

f. Foreign Trade Promotion

Although the Task Force was not able to examine foreign trade promotion in depth, it noted a concern from those in industry about the follow-through on some promotional activities. This report describes opportunities for technology development in Canada which could be assisted by the selective foreign promotion of unique Canadian equipment, processes and services.

6.2 Financial Incentives

Certain incentives can reduce the risks associated with developing pollution control technologies. Public support for projects whose benefits are largely social, in other words, whose benefits are shared by many rather than a few, can be justified. On this basis, developments that would benefit an entire industry rather than a particular company, or that would lead to the widespread creation of jobs and exports are supported with public funds. Environmental protection technology developments should be supported for the same reasons. Indeed, not only are there often widely shared economic benefits to these developments, the non-economic benefits from protecting the environment are even more broadly shared.

While it is possible to justify public support for the development of environmental protection technologies, it is more difficult to select the most appropriate form of support. Different sectors of industry are affected differently by the various types of incentives. Tax incentives for research and development are useful for profit-generating enterprises, but do not provide an adequate incentive for companies in early stages of their development, or companies whose profits are small or non-existent. To stimulate R&D in such companies, direct support such as contracts or grants would be more effective.

The level of assistance necessary to induce companies to increase their research depends on the ability of the company to capitalize on the results of the research. Nevertheless, experience with CPAR and EDP shows that research in environmental protection is best stimulated when it is fully funded.

Regardless of the degree of support offered, the assistance program should be easily understood by those who could use it. There should be clear eligibility and selection rules, straight-forward mechanisms and minimal red tape. Finally, there should be little delay between proposal submission and funding decision.

Earlier, impediments to innovation were identified and the need for demonstration projects emphasized. The significant costs and risks at this crucial stage have frustrated the commercialization of promising technologies. The general benefits that can come from the successful commercialization of environmental protection technologies justify reduction of the financial risks to both vendor and buyer by government assistance at the demonstration stage. As well, a more general sharing of the consequences, such as allowing the proponent of a new process the time necessary to discover and solve the start-up problems associated with full scale operation (and so recognizing that the environment may continue to be damaged for a while), may be warranted.

Several possible aspects of financial incentives are discussed below.

a. **An Incentive Program for Industrial Research, Development and Demonstration**

The Enterprise Development Program is now the chief federal industrial assistance program for the research, development and demonstration of environmental protection technologies. It was not initially set up to provide assistance in this area and even in its modified form it is ineffective. In particular, this program has been unsuccessful in stimulating research in environmental protection.

A new program could be developed which would provide for full funding of industrial research and partial assistance throughout the entire innovation process through to, and including demonstration. This program would complement the existing range of incentive programs by meeting the needs for environmental protection research and development assistance that are not now being met. It would be a small program particularly aimed at stimulating research, thereby correcting the most obvious deficiency of EDP, and also well suited to assisting small to medium-sized demonstration projects.

This federal program could be administered by the Department of the Environment, and could be funded by transferring money from the budget for EDP. It should follow the pattern set by federal programs such as CPAR and ENFOR and use an advisory committee which includes experts from outside of government. Whatever procedures are established for this program, they should be straightforward, so that all are able to take advantage of them.

b. Incentives for Research in Universities

Universities have an important place in the development of environmental protection technologies. To promote an interest in the environmental field among academics, this field could be identified as one of the priority research categories supported by Strategic Grants disbursed by the Natural Sciences and Engineering Research Council.

c. One-Window Approach to Industrial Assistance

At present, several programs provide assistance at different stages of the innovation process. The need for different programs administered by different agencies is recognized. The Task Force was told by several industry officials that "one-window" between industry and government to deal with all requests for assistance to innovation would create more problems than it would solve. However, to help companies and individuals through the maze of programs, an information contact in the federal government could be made available. This contact would provide advice on appropriate programs and their procedures which could be used to support research, development or demonstration related to environmental protection technologies.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

1. Canada's unique environmental problems result from its geography, climate and economic development. These, in turn, lead to particular opportunities for the development of environmental protection technologies.

2. Present employment in the manufacturing of environmental protection equipment is very small, and the domestic market for environmental protection equipment is likely to remain small compared to other manufacturing markets.

3. Economic opportunities were found in:
- equipment and instrumentation
- industrial process development to reduce environmental impact
- recycling of wastes
- services
- training both in Canada and abroad.

4. The "best commercial opportunities" with the largest potential immediate economic impact (such as employment, export potential, value added in Canada) include:
- automated control systems
- environmental services
- monitoring equipment
- remote data gathering
- waste control and disposal techniques for temperate and cold climates.

5. In the long run, optimal environmental management will be achieved through improved harvesting, extraction, processing and manufacturing technologies, which avoid the problems of existing technologies.

6. Impediments to innovation in the area of pollution control technologies include:

- regulatory procedures which favour the use of existing technologies at the expense of new, innovative alternatives
- conservatism which leads to the continued use of known technologies
- structure of industry including the small size of potential manufacturers and the nature of foreign ownership
- the apparent large risks and costs involved in adopting fundamentally different production processes
- social attitudes which frustrate attempts to install waste treatment facilities.

7. Technology gaps requiring further research to develop new cost-effective technologies include:

- limiting the effects of acid deposition — by both improvement in the control of acidic gases and amelioration of their effects
- personal monitoring of exposure to hazardous substances in the work place
- disposal of toxic substances (including both nuclear and non-nuclear wastes)
- noise control
- elimination of odours.

8. Present federal government arrangements to provide financial assistance for the development of environmental protection technologies are cumbersome and not well suited to the particular needs of innovation in this area.

9. The federal government's efforts to encourage development of air pollution control technologies are lacking.

7.2 Recommendations

1. Existing financial incentives (both direct grants and tax deductions) should be restructured to encourage the development and commercialization of environmental protection technologies. In particular, the present incentive arrangement for development of environmental protection technologies in industry through the Enterprise Development Program should be replaced with a workable program to assist development and demonstration of environmental protection technologies.

This new program should provide assistance to industry through direct funding of research and shared cost funding of development and demonstration. Funds should be disbursed according to streamlined, easily understood procedures. The advisory committee which reviews proposals for financial support under the program should include non-government personnel.

To meet present needs, approximately 10% of the EDP funds allocated to product "innovation" should be transferred from EDP to fund the new program which should be administered by the Department of the Environment. This level of funding (approximately $7 million per annum) should be adequate to support most worthwhile applications. The new program should supplement the present arrangement so that, for example, EDP could still be used to support environmental protection projects which could not be funded by the limited new program provided they met the existing EDP criteria.

2. Governments should be flexible with pollution control regulations in particular situations, to allow for the start up difficulties and possible early malfunctioning of innovative environmental protection systems and to give new technologies the time to prove themselves in their first installations.

3. Governments should use their purchasing power to support the development and commercialization of innovative Canadian technologies. The federal government should lead in this and encourage provincial, regional and municipal governments to follow its example.

4. Environmental protection research and development in universities should receive increased federal government support by identifying environmental protection as a priority research category within the NSERC Strategic Grants Program.

5. The Department of the Environment should increase its efforts in fostering the development of air pollution control technologies.

6. The federal government should advocate the development and use of environmental regulations based on desired result rather than stipulating procedures to be used, so as to encourage the commercialization of innovative environmental protection technologies in Canada.

APPENDIX A

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APPENDIX B

Federal R&D Assistance Programs applicable to Pollution Abatement

Program	Crown Contribution	Title to Results	Eligibility	Supportable Activities	Responsible Department
EDP (Enterprise Development Program)	Up to 50% or 75%(1) of project costs	Company	Taxable Corporation	Research, Development Demonstration	Industry, Trade & Commerce
UP Unsolicited Proposals Fund	100% of project costs(2)	Crown	No Restriction	Research and Development	Supply and Services and a client Department
IRAP Industrial Research Assistance Program	Salary Costs of technical personnel up to 66% of project costs	Company	Most companies	Research	National Research Council
PILP Program for Industry/ Laboratory projects (include COPI)	Up to 100%	Crown(3) or company	Qualified Companies	Commercialization of Crown owned Technology	National Research Council
DRECT Development of Resource and Energy Conservation Technology	Up to 50%	Company	No Restriction	Development and Demonstration	Energy, Mines and Resources

NOTES: (1) Maximum 50% for large companies with annual sales over $10 million, 75% max. for small companies
(2) Capital costs are generally not eligible.
(3) Company pays royalty to use background technology but may retain title to added technology if contributed to funding the project.