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ENVIRONMENTAL SCIENCE AND TECHNOLOGIES TO SUPPORT CANADIAN INDUSTRIES: EARLY OPTIONS VOLUME 2: ANALYSIS REPORT

REVIEW DRAFT

ENVIRONMENTAL SCIENCE AND TECHNOLOGIES TO SUPPORT CANADIAN INDUSTRIES: EARLY OPTIONS VOLUME 2: ANALYSIS REPORT

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1. INDUSTRY, SCIENCE AND TECHNOLOGY CANADA AND ENVIRONMENTAL SCIENCE AND TECHNOLOGY

1.1 Purpose of This Report

The purpose of this report is to assist ISTC in work with its clients to identify new and expanding markets for environmental science and technology, which the Department can support the universities and the private sector to enter and exploit.

The report attempts to sort through the large number of competing options for early attention by applying key analytical concepts, and reaching some sensible starting points for action on early options.

As will be documented here, early options for promoting environmental science and technology could arise from the following:

- new science and technology needs arising from new Federal and international environmental regulations, especially as they impact on the resource industries sector and other sectors under challenge;
- new science and technology procurement requirements arising from the need to "get the Federal house in order" from an environmental perspective;
- new industrial needs and market opportunities arising from political change in Eastern Europe and in the Third World, including their domestic impacts on the Canadian defence industries;
- new risks and opportunities arising from the process of monitoring the environment and measuring the effects of human activities on it.

This report reviews each of the above sets of considerations and then

- identifies some actual "early options" within environmental science and technology for pursuit in the next two to three years, while more in-depth studies are taking place and a consensus is being built on those results; this will help to show that the Department of Industry, Science and Technology is actively at work in the field;

- tests the science and technology selection process itself, using the attempt to choose a few early winners as a way of determining its applicability and subtlety; this will provide valuable learning for the creation of a long-term strategy.

The development of insights about each of these topics involves consideration of four key sources of information:

- the literature on both environmental science and technology, and on the process of technological change as a whole including the state of current developments in public and private sector technology centres;

- the views of industry associations and environmental groups on the priorities for technology development;

- the key "drivers" of technological change as a whole, including those most obviously linked to environmental impacts;

- the views of Federal officials most directly concerned with environmental science and technologies.

1.2 The Role of Industry, Science and Technology Canada in Relation to Environmental Science and Technologies

The Department of Industry, Science and Technology plays a dual role with respect to environmental science and technologies and the universities, research institutes, and industries which produce them. This places the department in a difficult position from time to time, and can lead to gaps or fragmentation in a government-wide approach to both users and producers of environmental technologies.

Such institutional considerations may seem remote from the task of choosing which new science and technologies to support in the future. In fact, these considerations affect the actual pursuit and implementation of this task in very direct and profound ways.

On the one hand, ISTC is charged with increasing Canadian competitiveness in domestic and world markets. To the extent that environmental technologies seem to act as a drag on competitiveness and a dead-weight cost to industry, ISTC may be called upon by various industry constituencies to oppose their adoption. More particularly, it may feel pressures to argue against regulations which call for these technologies and science associated with them.

On the other hand, the environmental industries are much like any other, and both need and deserve appropriate and equitable Federal support to the extent that they can generate high-quality jobs, expanded domestic capacity, and export earnings for Canada. Moreover, they may hold the key to the future prosperity of vital Canadian sectors such as the automotive industries, forest products, ocean industries and defence production

In many cases, users have discovered that the introduction of environmental regulations and technologies has promoted greater domestic and international competitiveness as well. The adoption of new pollution-control or lower-waste and energy technologies is often carried out in the midst of overall modernization/ expansion projects.

In 1988-89, the Department contributed approximately $105 million to activities of this type under various pro-grams, especially IRDP, DIPP, and ERDA subagreements.

To the extent that, for example, modernization of the pulp and paper industry has involved installation of new and more efficient machinery, or construction of new, more energy-efficient plants, it has also typically resulted in reduced environmental degradation.

1.3 Current State of Industry Views on Environmental Science and Technologies

On the whole, however, the conventional approach to addressing the pollutants produced by industry in the course of its resource extraction, production, sales and distribution activities has been one of "reacting and curing".

That is, to develop and add specialized technologies or remedial measures after the major production processes have been completed. The scientific laws of physics and chemistry, energy and materials, push in the direction of this being a more costly approach, at least in the longer run and when all costs are considered.

In certain dramatic instances, such as the Bhopal disaster, the Exxon Valdez oil spill, the Hagersville tire fire, and the St.-Basile-Le-Grand PCB (polychlori-nated biphenyl) fire, the costs to industry of reacting after the event have been or will be truly staggering. Indeed, the ripple effects of such incidents have spread far beyond the chemicals, petroleum, rubber, or waste management industries.

They have coloured the public perception of industry as a whole, and undermined public trust. They have substantially increased the pressures on governments to introduce still more laws, regulations, and enforcement staff to police them. Virtually all such laws have been introduced by nominally "pro-business" governments, and in some cases by very actively pro-industry governments.

The combined effect of increased regulation, reduced public trust, some public panic, and genuine business concern as fellow humans to "do the right thing" has been to shift the balance of leading industry opinion in favour of anticipating and preventing environmental degradation. This has been evident in positions taken by key spokesmen for the Business Council on National Issues, the Canadian Chamber of Commerce, the Canadian Chemical Producers' Association, the Canadian Petroleum Association, and others.

From internal documentation received and contacts with other associations in the course of preparing this report, it is clear to the author that there is more of such a shift in industry opinion to come. The problem, therefore, does not appear to be one of a general lack of industry willingness to operate in a fundamentally different way in the future. The costs of both inaction and reacting after the fact are quite clear to most aware corporate executives.

1.4 Barriers to a More Rapid Shift to "Anticipate-and-Prevent" Approaches

There are, however, fundamental barriers to action which matches rhetorical commitments to sustainable development and "anticipate-and-prevent" approaches to environmental science and technology.

Several become immediately evident upon even a cursory review of the considerations which must face virtually every industry executive in choosing a path for the future.

First, is the immense amount of "sunk" capital in existing plant, machinery, inventory, and organizational arrangements, worth hundreds of billions of dollars, which simply cannot be written off.

Second, there is the shocking profusion of fragmented, often conflicting and disjointed scientific advice and technical information which they will encounter in seeking to reach sensible decisions about how to give effect to their environmental objectives. A recent study of the United States "Superfund" identifies problems of selecting the most effective environmental technology as the key one in achieving intended results.[1]

In the course of preparing this report, the author consulted over 500 different articles, books, monographs and other sources of relevant information. Only a small fraction, perhaps 5%, of the literature was geared to executive decision-making, and within this, an even smaller proportion of the total dealt with anticipatory approaches. A handful of articles and books put forward alternative methods of resolving environmental problems before they occur through costed, readily comprehensible technical choices.

While consulting engineers and others play an extremely valuable role in recommending technological options to their clients, the situation is rapidly getting beyond even their capacities to keep up. Moreover, many medium and smaller firms cannot afford special-purpose studies and must rely instead on publicly-available sources of information.

Beyond the fragmentation and confusion of the expert advice on new ways of addressing pollution is the demonstrated conservatism of the professional engineers and others who embody and convey that advice on a practical day-to-day basis.

Had the major Japanese auto manufacturers been allowed to take the advice of their automotive engineers in the early 1970s, they might have continued to work around the edges of an essentially unchanged engine, burning leaded gasoline.

They were instead forced by a combination of public pressure and "renegade" engineering in smaller firms to modify both the basic combustion process and the fuel called for. The result was a fundamental improvement in their comparative competitiveness and performance from which their slower-moving rivals have never recovered.

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[1] Congress of the United States, Office of Technology Assessment, Are We Cleaning Up?: 10 Superfund Case Studies (Washington, D.C.: U.S. Government Printing Office, 1988). While this report deals with remedial technologies rather than preventive technologies, the findings apply more widely.

Process and other engineers tend to favour marginal changes to established technologies for good reasons, however. Their mandate is to achieve industrial systems which work consistently, with the least "down time" and fewest rejects.

Like other professionals, they may also get out of date with new technical developments, and find the precise information they require to justify the risks of a new process or product difficult to obtain. Within the profession and corporate structures, environmental engineers are still a relatively new breed, and a minority voice.

Knowing the corporate concern for quarterly results, engineers within the corporate hierarchy may have little incentive to "rock the boat" by advocating costly new technologies with unproven performance. The net result may, however, be inertia which returns the firm, industry or sector to the position of having to react after the fact to the disturbing event of an accident or a new government regulation.

Those responsible for process engineering may be willing in principle to recommend new approaches. As David Pounder of the United Kingdom Department of the Environment pointed out in his paper for the "Globe '90" Conference, methods of analysis for waste minimization may not be well-developed.[2]

Moreover, as suggested by David Berg at the same conference, the culture of the "command-and-control" approach to environmental regulation is still very strong, even in the private sector. This is at odds with a technological innovation approach to sustainable development.[3]

Overall then, the difficulty faced by ISTC is that, despite the new mood of industry leaders, its major industry constituencies remain in a "react-and-cure" mode in relation both the environmental regulations and technologies.

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[2] "Cleaner Production: Setting the Targets for New Design" (Vancouver: Globe '90 Conference Abstracts, 1990).

[3] "Technology Innovation for Environmental Purposes" (Vancouver: Globe '90 Conference Abstracts, 1990).

1.5 Environmental Science and Technology as Part of ISTC's "Core Business"

Actions to promote new environmental science and technology cannot alone reshape fundamental economic realities of Canadian industry. But they can help to remove specific obstacles to technological change in given "flagship" sectors, production processes, product lines and services which will serve to bring reality and rhetoric closer together. They can assist in making the anticipate-and-prevent philosophy less risky, more familiar and legitimate. For the core of technological change processes is not the technologies themselves, but the shifts in managerial perceptions and styles, in skills and modes of operation, and in economic relationships which they bring about.

In this regard, it is important for ISTC itself to consider the relationship between environmental science and technologies and the environmental industries and its "core business". The latter are not simply an "add on" which entails the definition of a formerly disparate range of machinery and equipment manufacturers and consulting/scientific services as a new industry group. They are or will become a central aspect of the Department's overall mandate, which is to preserve and enhance Canada's major strengths in domestic markets and international trade.

Exposure to environmental science and technology activities and concerns will help to bring the Department into the process of environmental regulation, both as a threat to Canadian strengths and as a new market opportunity. It will help to achieve the realization that one industry's "cost" may be another's profit, just as one industry's "waste" may be another's valuable raw material.

To put the matter another way, in the future era of increasing trade liberalization, labelling requirements and "environmental" regulations may become two of the strongest remaining methods of protecting domestic industries. The news from the front lines of Canada's major competitors is that none of them is moving to relax environmental standards, quite the reverse.

As well, the leading economic powers are moving fairly rapidly in the direction of "clean technologies" or industrial technologies which produce zero or low discharges into the environment.

In brief, either based on realities or pretexts, major markets could be closed off or curtailed in the future if Canadian industry does not move at least as fast as its rivals on environmental matters. The fate of the Canadian sealing and asbestos industries is instructive. In both cases, significant merits of industry arguments were lost in the rush to regulate on grounds of environmental concern; in both cases industries appeared to be reacting to agendas set elsewhere, rather than on ground of their own choosing.

1.6 Role of ISTC in Relation to Environment Canada

Taking environmental factors and the environmental industries into the core business of ISTC entails new relationships with other Federal actors. In particular, ISTC will need to consider its role vis-a-vis the main Federal agency responsible for setting the pace of regulatory change and the environmental policy agenda, Environment Canada. It is beyond the scope of this paper to comment on the future relationship more broadly. But a very specific case in point has major relevance for the selection of which environmental technologies, if any, should receive early ISTC backing.

Each year, Environment Canada develops and puts into force an array of regulations under the Canadian Environmental Protection Act and other legislation.

The docket for 1990 alone totals 45 items, although several are interrelated. Twenty-nine of the 45 have a direct bearing on the fate of key Canadian industries, and yield major market opportunities for the domestic environmental industries as well.

Yet there is a gap in the functions performed by Federal institutions at the moment:

- Environment Canada considers the economic impacts of regulations which it develops, but only up to the point of making the case for the viability and technical feasibility of the regulation;

- Industry, Science and Technology Canada may subsequently respond to requests from industries for assistance in meeting the new regulation or in supplying the technologies and services needed to comply with it.

No one is currently responsible for turning regulatory impact statements into statements of industrial opportunity, far enough in advance of the date of coming into force that Canadian industry can be ready. Moreover, many of the results of extensive Environment Canada consultations with industry and technological feasibility assessments remain in their files, rather than being repackaged as product development and marketing intelligence for the environmental industries.

Regulations concerning replacements for chlorofluorocarbons (CFCs) and halons, published in the Canada Gazette in July and November of 1989. There are impact statements to the effect that major scientific and technology development work remain to be done to achieve compliance and/or that Canada will have to import the substitute chemicals. Excellent analytical efforts, gaining international recognition, have been made by Canadian experts on alternatives to CFCs and halons. Yet, to date, no industrial strategy has been developed. While Dupont has a major Canadian investment underway which could position Canada strategically in this field, even this is subject to major regulatory uncertainty.

It does not seem very productive for ISTC to carry out extensive scanning exercises relating to environmental technologies and opportunities for the environmental industries while a basic loop within the Federal system is left unclosed.

For many intents and purposes, "early options" science and technologies have already been chosen by Environment Canada and leading provincial agencies through regulatory processes. It remains to capitalize on those choices from an industry development perspective.

Accordingly, there is an opportunity for ISTC to convert information and industry consultation results assembled by Environment Canada as part of the regulatory process into scientific, technological and industrial strategy formats.

Resulting statements of market opportunities could result in support via the Technology Outreach Program, support under the Technology Inflow Program, and additions to the briefs available from the Market Intelligence Service. They might also include activities under the Strategic Technologies Program.

Priorities for 1990 would be:

- ozone-depleting substances, already mentioned above;

- pulp and paper production processes;

- PCB waste storage and treatment;
- transportation of hazardous wastes and toxic substances;
- ship-board systems for dealing with wastes and hazardous products;
- solid waste incineration technology;
- boiler-related pollution prevention and control technology.

In each of the these cases, the nature of the market has already largely been established. But considerable work may still be needed to help private industry to exploit that market. An integrated ISTC-Environment Canada approach to tracing opportunities for the environmental industries arising from Federal regulations needs to be put in place.

1.7 The Changing World Economic Context

As noted above, ISTC's core business is helping Canada to compete in the world economy of the 1990s and the 21st century. To do so successfully, we will need to find and develop new market niches which make the best use of our comparative and competitive advantages.

Dramatic changes are underway in the international alignment of economic forces. These include:

- the drift of many conventional manufacturing activities to Third World countries;
- the rise of Japan toward world economic dominance;
- the reintegration of Eastern Europe and the Soviet Union into the community of nations and into international economic institutions;
- the resolution of certain key conflicts in the Third World, and a shift in resources from military purposes both for this reason, and because of changes in Eastern Europe;
- the creation of a more complete economic union in Western Europe in 1992.

In such a context, major Canadian advantages will arise from our position of access to larger North American markets, our large pool of highly-qualified personnel, our strong infrastructure, and our long traditions of public/private cooperation.

The other new element of doing business in the 1990s -- the environment -- needs to be related systematically to the large changes just mentioned. Will the new world order be one of "havens" from regulation and regulatory "free-fire zones", depending on the inclinations of leaders and population? It appears, overall, that new industrial growth of all kinds will need to meet higher environmental standards or face major international as well as domestic pressures to operate differently.

1.8 Environmental Science and Technology Producers

Canada already has a major, though somewhat underdeveloped and fragmented, array of producers of environmental science and technology to help it respond to the new competitive situation.

These include: specialized research and development institutes; producers of pollution-control equipment; producers of "clean-technology" industrial processes; environmental design consultants; producers of environmental sensing instruments and interpreters of their results; recyclers of waste materials; producers of "environmental choice" consumer products, and others.

In general, these research centres and firms are elaborating on or using imported components and standard methods developed over years of practice. However, there have been notable Canadian scientific and technological developments in such fields as residential energy conservation, use of remote sensing and geographic information systems to determine environmental degradation, ocean sciences, bioengineering to break down wastes organically, and development of recycling methods.

1.9 Impact of Public Sector Decisions on Environmental Science and Technology

Beyond the specific Canadian Environmental Protection Act regulations mentioned above, other needs and markets for environmental science and technology are being set by actual or anticipated public sector actions to increase environmental and health standards. As well, changing consumer preferences have an impact, driven in turn by public sector data collection and reports on the state of the environment.

The issue is whether the technologies and expertise exist anywhere in the world to address all of the new tasks at hand. Will the Canadian industry be able to take full advantage of the markets created here and by similar actions in other countries? How should the Federal government work with the private sector, universities, and others to take the fullest advantages of these new challenges and opportunities? These are the key questions being addressed by the environmental science and technology work of the Department of Industry, Science and Technology.

2. THE RATIONALE FOR EARLY OPTIONS

2.1 Why Choose?

The need for ISTC to determine the industrial implications of environmental regulatory actions which the Federal government itself takes may appear self-evident. However, choosing technologies on purely environmental grounds, and choosing them on grounds of increased international competitiveness may be two quite different things. Both processes are legitimate, and need to happen.

As the comments at the end of the first section indicate, it is important not to curtail the second type of activity just because the environmental need assessment is already taking place or has been completed.

The case for choosing amongst the specific technologies available and singling them out for some kind of government support still has to be made however. Indeed, though government regulations may be the main drivers for creation and expansion of environmental industries, the user firms affected may be quite capable of purchasing what they need from the private market. Accordingly, why is it necessary for Industry, Science and Technology Canada to work with the industry in choosing among technologies to be supported at all?

Briefly, there are five major reasons:

- because the public expects the Federal government to bend its efforts to solving environmental problems;

- because, as noted already, the government has generated the need for the new technologies itself through its regulatory actions, and cannot expect foreign suppliers to provide technologies and services appropriate to Canadian conditions in all circumstances; the variety of new demands on environmental science and technology coming all at once requires concentration of highly-qualified personnel, research labs, and public funds on the areas of greatest economic and environmental payoff;

- because Canada has committed itself to fulfill international obligations relating to environmental clean-up and prevention;

- because Canada's international competitors among the developed countries are already providing major aid to their own environmental industries, both a way of solving internal environmental problems, and as a method of tapping new global markets; if Canada does not compete, its balance of payments deficit in machinery, equipment and business services will continue to increase, and large amounts of taxpayer funds devoted to environmental clean-up will effectively go offshore;

- because, through the consultation paper, A Framework for Discussion on the Environment, the Minister of the Environment has created the expectation of vigorous Federal action in relation to environmental technologies.

Let us consider each of these factors briefly.

2.2 Response to a National Consensus

Public opinion polls, daily press coverage, and individual actions on environmental concerns all point in the direction of sustained public interest in environmental protection. In this field, science and technology appear to be lagging behind public expectations.

To an extent, the credibility of the scientific and technological communities as a whole appear to be at stake, from two vantage points. First, the advancement of science and technology themselves appear to have contributed to environmental degradation in a major way, through the creation of new toxic chemicals, new industrial processes, and unanticipated effects on health and nature. Second, solutions offered to many of the environmental problems which have emerged appear clumsy or inadequate, costly or inconvenient, relative to the elegance of many other technological solutions. This appears to be a field in which current effort lags behind human needs and other sectors of science and technology.

2.3 Recent Government Initiatives

Quite apart from the current regulatory initiatives under the Canadian Environmental Protection Act, to be detailed further in the next section, there are a variety of other Federal, Provincial, and joint Federal/Provincial initiatives on the environment.

These include:

- o new automotive emission standards under the Motor Vehicle Safety Act;
- o a national regulatory strategy for controlling water pollution from pulp and paper mills;
- o a solid waste reduction target of 50% by the year 2000, which calls for major action by the packaging industry in particular;
- o a Federal/provincial management plan for reducing urban smog, including nitrogen oxides (NOx) and volatile organic compounds (VOCs);
- o a progressively tighter process of regulating industrial and municipal water-borne effluents in Ontario under the Municipal-Industrial Strategy for Abatement (MISA) program, and in Quebec under the St. Lawrence Action Plan;
- o a $250 million national clean-up program for contaminated land sites;
- o a plan for management of used tires.

2.4 International Commitments

Beyond the above initiatives, a 1987 update of the Great Lakes Water Quality Agreement between Canada and the United States has led to accelerated action by the Federal and Ontario governments on these bodies of water. In particular, attention is being given to "critical pollutants", and to "Remedial Action Plans" to address "Areas of Concern". A particular challenge posed in the implementation of these action plans is how to clean up contaminated sediments on the lake bottom. Pulp and paper mills in both Ontario and Quebec are especially likely to be sources of "pollution hotspots" forming the focus of Areas of Concern.

In working toward a Canada/U.S. Accord on acid rain, there are bound to be further calls for reduced sulphur dioxide and nitrogen oxide emissions from Canadian sources. In any case, Canada is a signatory to the United Nations Economic Commission for Europe Protocol calling for higher standards to control nitrogen oxide emissions.

During his trip to the Soviet Union in November, 1989, the Prime Minister signed a series of agreements and memoranda of understanding with President Mikhail Gorbachev on water, air, and Arctic environmental matters. Each refers explicitly to technology development, and implicitly recognizes the tremendous need in the Soviet Union for accelerated action to put environmental technologies into place.

2.5 Actions by Other National Governments

A growing aspect of the management environment of Canadian executives, especially in the chemicals and pulp and paper industries is the impact of United States and European laws requiring recycled content in major export goods.

For example, Connecticut has passed legislation that will require newspapers in that state to use recycled newsprint by 1993, and to increase that use to 90% of their consumption by 2000. Eighteen mills in Canada are already using some portion of recyclable waste paper as a result of this and other moves in major U.S. markets.

As the "GLOBE '90" international conference and trade fair held March 19 - 23, 1990 in Vancouver demonstrated, there are many opportunities for international trade in environmental technologies. Moreover, Canada's competitors appear well positioned to take advantage of these opportunities. As just one example, whereas Canada currently has 10 categories of consumer products officially designated as "green" or "environmental choice" items, West Germany reportedly has 2,500.

The North American market for environmental technologies alone is estimated to be in the $106 billion range, although categories of measurement and definitions use vary.

2.6 The "Green Plan"

On March 29, 1990 the Minister of the Environment initiated a public dialogue on environmental issues leading to a "Green Plan" for the autumn of 1990.

The ... Framework for Discussion on the Environment makes the following statements and commitments:

- "The Government proposes to increase significantly its commitment to environmental science and technology";

- "... a Federal government panel, similar to the existing Panel on Energy Research and Development, is being considered to identify priorities and mobilize public and private sector resources";

- "The Government is also considering a new program, to be administered by the three national granting councils ... to promote fundamental environmental research at Canadian universities";

- "Consideration may be given to ... a program for funding research proposals originating from outside the Government";

- "The Government will put in place mechanisms to promote the demonstration and commercialization of environmental technologies. One possibility is a government/private sector cost-shared technology demonstration fund."

- "The Government proposes to strengthen its support of international efforts to address environmental problems. Possibilities include ... funding and technology transfer to help developing countries to overcome environmental problems."

The proposals and commitments amount to containers waiting to be filled with the substance of priorities for work on environmental science and technologies. The Federal government itself is the largest single business in Canada, and probably has environmental impacts which equal or exceed those of the larger industrial corporations.

In recognition of this fact, the Environment Minister has proposed as part of the Government's Green Plan that there be a "code of environmental stewardship" to guide Federal activities, together with very specific goals or targets and schedules relating to environmental performance and clean-up.

It is not clear that the science and technology exist to solve many of the problems to which the Federal goals and targets are addressed, much less those of the society as a whole. Federal procurement in relation to getting its own house in order can be a tool for meeting both governmental and private sector challenges at the same time.

Environment Canada is deeply involved in the work of developing environmental technologies, but not from the perspective of developing Canadian industrial strengths for the most part. Officials in the department have definite, considered views on strengths and weaknesses of Canadian technologies available within their individual areas of specialization. The Wastewater Technology Centre and the River Road Environmental Technology Centre have specific long-standing projects involving industry, especially in relation to treatment of sludge, sewage treatment process controls, and oil-spill clean-up technologies.

However, the department is clearly looking to ISTC to provide industry development leadership. This paper seeks to offer a reasonable starting point in developing that leadership position.

In order for ISTC to play the role of working with the private sector to define an industrial strategy for the environmental industries, it will need to consider in some detail:

- the Canadian regulatory initiatives and clean-up programs already underway;
- international initiatives, including those in the United States and Western Europe
- getting the Federal house in order;
- the environmental needs and challenges arising from the changes in the international situation, especially as it relates to Eastern Europe, the Third World, and the Canadian defence industries;
- changing consumer preferences which may be driving market demand, quite apart from regulatory measures;
- the dimensions of choice from a domestic and private sector Canadian perspective.

These topics are addressed in the sections which follow.

3. CANADIAN REGULATORY INITIATIVES AND CLEAN-UP PROGRAMS

3.1 Canadian Environmental Protection Act

The Canadian Environmental Protection Act was adopted on June 30, 1988. With this legislation, the Federal government has initiated a major process which will ultimately affect every known toxic chemical. In all 20,000 chemicals or groups of chemicals are expected to come under this regulatory regime.

The legislation requires all new compounds to pass through a screening process. In addition, existing chemical substances are gradually being assessed, and those which appear to require regulation are being placed on a "Priority Substances List". Forty-four of the most toxic chemicals or groups of chemicals have been chosen for early regulation. To date, there remain many scientific and technological problems in safely producing, storing, using and disposing of such chemicals.

Using the authority under the Act, the government has already proceeded, in conjunction with the Provinces, to begin the process of regulating more closely and phasing out PCBs (polychlorinated biphenyls) and CFCs (chloroflourocarbons). In both cases, alternative chemicals or methods are required to perform the same functions.

In addition, under Part IV of the Canadian Environmental Protection Act, the Federal government has the capacity to regulate its own activities more closely. Regulations are being developed or have been promulgated already for boilers, incinerators, contaminated waste sites, sewage treatment facilities and other environmental threats under direct Federal control.

The process of defining additional chemicals to be regulated is a deliberative one, which takes place over two or three years under normal conditions. There is plenty of scope for ISTC to begin the consideration of industry development opportunities early in the regulatory process. Then the potential for promoting Canadian suppliers of chemical management technologies is likely to be at its peak.

3.2 Montreal Protocol on Chlorofluorocarbons

In September of 1987, an event occurred in Montreal which is likely to be repeated often in the next decade. The first international treaty to control substances depleting the ozone layer was signed. This was also the first "anticipate-and-prevent" environmental treaty in history, and the first to set up a science-driven control strategy.

The main substances controlled under the Montreal Protocol are chlorofluorocarbons (CFCs) and bromofluorocarbons (halons), used in refrigeration, propellants, foam plastics, and in fire extinguishers respectively. Under the Protocol, consumption is to be cut to 50% of the 1986 levels by June 30, 1999.

This Protocol was signed even though the technological means to replace CFCs in many current uses do not exist at present, at least in a generally-accepted form.

At present, all halons used in Canada are imported from the United States. There are two domestic producers of CFCs, including Dupont Canada, which is actively working on substitutes. A report entitled Preserving the Ozone Layer: A First Step drew out the preliminary implications of converting from these substances. In addition, an international Technology Review Panel completed a major report on scientific and technical progress in replacing these substances in June of 1989.[4] Two of the six experts who led the panel process were Canadian.

Overall, it is clear that it would not be safe to assume that a few large-scale replacements, produced by major chemical manufacturers, will be forthcoming. There are remaining doubts about halogenated chlorofluorocarbons (HCFCs) as replacements, and no replacements in sight for halons in certain major uses.

As in the case of other substances regulated under the Canadian Environmental Protection Act, the purely environmental side of scientific and technological analysis appears to be proceeding well. The industry development side seems to be lagging.

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[4] Technical Progress on Protecting the Ozone Layer, (Nairobi: United Nations Environment Programme, 1989).

3.3 New Automotive Emission Standards

In July of 1989, the Minister of the Environment announced that lead would need to be phased out of gasoline by December 1, 1990. This represented an acceleration of the previous phase-out date of the end of 1992, based on new health findings about the effects of lead, especially on children. Only agricultural machines, boats, and heavy-duty trucks are exempt from the new regulation.

As well, the Minister of Transport and the Minister of the Environment announced in February of 1990 a plan to reduce automotive emissions of nitrogen oxide and hydrocarbons by 60% and 29% respectively. The new standards would be introduced with 1994 model-year cars and fully implemented for the 1995 model-year.

The proposed reductions are in line with those proposed for 1995 in California. In conjunction with the Federal regulatory action the Ministers of the Environment from both Federal and provincial governments are working on a ten-year management strategy for all sources of nitrogen oxide as well as "volatile organic compounds" produced by gasoline.

It is likely that the lead role in developing methods to meet new standards will be taken by the auto manufacturers, operating in conjunction with the U.S. side of the industry. The Automotive Industries Association of Canada has been making representations against moving ahead of the United States manufacturers.

There is nevertheless a case to be made for ISTC preparing a market opportunity statement for auto parts manufacturers based in Canada on the implications of the proposed new standards on both sides of the border for their business.

3.4 New Standards for Nitrogen Oxides

As noted immediately above, a ten-year strategy for controlling nitrogen oxides, especially from motor vehicles, is being developed on a Federal/Provincial basis.

The Federal role in this process is broader than changes to the auto emission standards, however. In 1988, Canada signed a Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution Concerning the Control of Emissions of Nitrogen Oxides of their Transboundary Fluxes.

Signatories are committed to apply national standards based on best available technologies to new stationary sources of nitrogen oxides and new mobile sources. As well, they are to act on pollution-control measures for existing sources. The signatories are also called upon to facilitate the exchange of technology.

The technologies suggested for use in stationary combustion give heavy emphasis to clean technology approaches, including fluidized bed combustion, flue gas recirculation, and reburning. Likewise, those indicated for automotive use include modifications to the basic combustion processes as well as tailpipe emission control through catalytic conversion.

There would appear to be a number of industrial opportunities inherent in the Protocol, especially in Eastern and Southern Europe, where such standards will be quite new.

In October of 1988, the Canadian Council of Ministers of the Environment requested a management plan for nitrogen oxides (NOx) and volatile organic compounds (VOCs), pursuant to the above Protocol and one being negotiated on VOCs. This plan is being developed in consultation with interested stakeholders and is to be delivered to the Ministers for consideration and final adoption in October, 1990.

The concern addressed by the plan is the health and environmental effects caused when NOx and VOCs combine in the presence of sunlight to form "groundlevel ozone" a major component of urban smog. Human lung tissue and vegetation are both damaged by this substance.

In all, the plan contains 61 emission reduction initiatives, including:

- energy conservation and product control;
- alterations in consumer choice and lifestyle;
- source control.

Total costs of implementing the plan are expected to be more than $630 million a year by early in the next century.

A series of five reports has been prepared on control technologies, covering mobile sources, large stationary sources, other smaller stationary sources, miscellaneous sources such as paints, and a summary. While there has been extensive industry involvement, no industrial opportunities statement has been prepared.

3.5 New Pulp and Paper Standards

At their meeting of March 20, 1990, the Ministers of the Environment from across Canada announced a commitment to a national regulatory strategy for water pollution from pulp and paper mills. This strategy will include:

- o nationally consistent water pollution control standards for the industry;
- o coordinated monitoring and enforcement procedures to minimize duplication;
- o a consistent "blanket" of environmental protection in all regions.

The major pulp and paper provinces, Quebec, Ontario, Manitoba, Alberta, and British Columbia have announced an intention to regulate the industry more closely, along with the Federal government, each within their own areas of jurisdiction.

The Federal regulatory package was announced on January 3, 1990, and consists of three parts. There are new regulations under the Canadian Environmental Protection Act to achieve virtual elimination of dioxins and furans in discharges from mills. New CEPA regulations or guidelines will control organochlorine discharges.

As well, amended regulations under the Fisheries Act will limit discharges as a whole, and make all mills, including those constructed before 1971 subject to regulations concerning suspended solids, oxygen-depleting substances, and lethal toxic effluents.

The new Federal regulations will begin to be phased in this year, and be completely in force by 1994.

The pulp and paper industry will be under intense and comprehensive pressure to modify its production processes and end-of-pipe technology as a result of the new regulatory framework. There appear to be major opportunities to apply closed-loop systems in response to the new standards. These eliminate the need to check discharges into nearby rivers, lakes, etc., entirely.

3.6 New Packaging Reduction Target

At their meeting of March 20, 1990, the Canadian Council of Ministers of the Environment endorsed a National Packaging Protocol for reducing packaging by 50% from 1988 levels, by the year 2000. As a first step, they established an interim national target of a 20% reduction by the year 1992.

The estimated saving from this interim target are $50 million annually in waste collection and disposal costs.

While the Ministers challenged the packaging industry to initiate voluntary measures to meet the target for 1992, they will nevertheless begin immediately to prepare compatible legislation and regulations to achieve the reductions.

The National Packaging Protocol resulting from the Ministers' work has major industry implications, calling for source-reduction and changes to make more packaging reusable and/or recyclable. It envisages a coordinated research and development initiative to demonstrate new reduction, reuse and recycling technologies. It proposes research on new applications of secondary packaging materials. It calls for development of domestic and overseas markets for Canadian technologies and products related to diversion of packaging waste from disposal, and also for demonstration of recycling systems.[5]

The background research for the Protocol to date has a major component of industry analysis, but does not pursue the opportunities of the future in any depth.

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[5] MacLaren Engineers, et.al., CCME National Task Force on Packaging: Phase I Final Report (Toronto: MacLaren Engineers, 1989), pp. 8-8 to 8-11.

3.7 Elimination of Polychlorinated Biphenyls (PCBs)

PCBs are a class of chemicals which are ideal for industrial use, in particular, cooling and insulating fluid for transformers and capacitors. The problem with them is that they are virtually indestructible once in the environment, and hence tend to concentrate in the food chain.

Health effects of sustained high-level exposure include muscle weakness, decreased immune system response, skin changes, irregular menstrual cycles, and reduction in size of fetuses. Virtually all humans now have detectable levels of PCBs in their bodies, although in levels unlikely to cause health effects.

The major uses of PCBs were discontinued in 1977, particularly in electrical transformers. Wastes generated as products are taken out service have been stored at various sites across Canada.

A particular danger posed by PCBs is that when they burn out of control, they produce many other chemicals, such as dioxins and furans which also have important health effects. Particles from a fire are widely spread and enter the water and soil.

In September of 1988, the Federal government issued an Interim Order under the Canadian Environmental Protection Act in response to a fire at a storage site in Saint-Basile-Le-Grand, Quebec. All Provinces except Prince Edward Island introduced compatible regulations.

A process of completely phasing out the use of PCBs across Canada is now underway, with a target of 1993 established by the Canadian Council of Ministers of the Environment. These wastes are being destroyed through a combination of mobile incineration and chemical treatment.

However, the mobile incineration program is beset by technological and operational problems. An alternative, biological treatment is still at an early stage of development and is not yet commercially available, according to a fact sheet prepared by Environment Canada. However, General Electric is currently testing a promising bacterial destruction process in the Hudson River.[6]

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[6] See Environmental Science and Technology, Vol. 24, No. 1 (January, 1990), p. 6.

As in the cases noted above, no comprehensive industry opportunities statement appears to have been prepared to date.

3.8 Clean-Up of Contaminated Sites

At the 1989 annual meeting of the Canadian Council of Ministers of the Environment, the Ministers agreed to initiate a $250 million program to clean up high-risk contaminated land sites across Canada. In several ways, this is similar to the "Superfund" program which has been in operation in the United States since 1980.

The Expo '86 site in Vancouver has been selected as the first area for a joint technology demonstration project, with the costs shared by the Federal and British Columbia governments.

While demonstration projects of this type will be useful, the experience of the United States with the Superfund on a much larger scale would appear to indicate the need for systematic scanning of treatment technologies.

The Federal sites alone under the clean-up program total 1133, many in fragile Arctic tundra. No comprehensive statement of the opportunities for different private sector suppliers of treatment services has been prepared as yet.

3.9 St. Lawrence Action Plan

The St. Lawrence Action Plan is a five-year cooperative project between the Federal government and the Government of Quebec. Total Federal investment in cleaning up the river is to be $110 million. Federal departments involved include Environment Canada, the Department of Fisheries and Oceans, and Industry, Science and Technology Canada.

Environment Canada has established the St. Lawrence Centre in Montreal in order to help develop new clean-up technologies applicable to the river. A total of $50 million of the St. Lawrence project budget has been allocated to technology development, including $37 million for industrial technology.

This project provides an excellent "window" into environmental technologies for ISTC, since it includes some of the most stressful industries, including pulp and paper, primary metals, and petrochemicals.

The Action Plan specifically calls for the application of clean technologies to the 50 priority industrial plants chosen for most urgent action. As of the end of March 1990, 20 of the plants were to be visited to assess their environmental impacts and the nature of their effluents.

There do not appear to be enough of any one type of plant involved in the St. Lawrence Action Plan to provide a major market for new environmental technologies. Therefore, it may be best to select an area which has application to both the St. Lawrence Plan and other parts of Canadian industry generally. In addtion, the St. Lawrence project offers a key opportunity to scan the best available remedial and clean technologies and to work out remaining "bugs" before applying them. In line with some of the other aspects of the work underway, the use of this effort to develop expert systems and other management decision-support tools of general applicability would appear to be high.

In June of 1989, the Federal and Quebec governments signed a cooperation agreement which resulted in the creation of joint Federal/Provincial team, with a target of reducing toxic liquid effluents by 90% by the year 1993. With such a short timeframe, development of new technologies from scratch would not appear to be a viable option.

To date, a market opportunity report for the project has not been prepared. This will probably not be feasible until the characterization of priority plants has been completed later this year.

3.10 Great Lakes Clean-Up Program

A 1987 update of the Great Lakes Water Quality Agreement between Canada and the United States has led to accelerated action by the Federal and Ontario governments on these bodies of water. In particular, attention is being given to "critical pollutants", and to "Remedial Action Plans" to address "Areas of Concern".

A particular challenge posed in the implementation of these action plans is how to clean up contaminated sediments on the lake bottom. Pulp and paper mills in both Ontario and Quebec are especially likely to be sources of "pollution hotspots" forming the focus of Areas of Concern.

Given the similarity of certain major clean-up problems on the St. Lawrence and along the Great Lakes, a comprehensive statement of the need for environmental science and technology development and diffusion would appear to make sense.

A recent trend in the work underway on Great Lakes clean up is the Program for Zero Discharge. This joint project of the Canadian Institute for Environmental Law and the U.S. National Wildlife Federation will seek to show how regulatory systems can be reformed to move from traditional pollution control to pollution prevention, or zero discharge.

3.11 Management of Used Tires

The Hagersville "tire fire" which burned for two weeks in March of 1990 has served to raise dramatically the question of how to deal with 25 million discarded tires across Canada. Assertions of the Ontario Minister of the Environment to the effect that it was preferable to recycle tires rather than using them as fuel appeared weak.

The Canadian Council of Ministers of the Environment have established a working group of environmental and fire prevention officials to consider scrap tire storage, disposal, and processing into other products. The group is to report with specific recommendations at the next Environment Ministers meeting.

3.12 Provincial Effluent Standards

At the provincial level, the Ontario government has developed the Municipal-Industry Strategy for Abatement, (MISA) and an airborne toxics equivalent.

The Government of Quebec is developing new air quality regulations covering 400 substances.

A recent review of provincial legislation affecting solid waste disposal reveals new legislation or regulations in this field has been developed in: Prince Edward Island, Nova Scotia, Quebec, Ontario, Saskatchewan, Alberta and British Columbia.[7]

In addition to regulatory initiatives, governments have committed themselves to major programs of recycling office wastes (Ontario), or of energy conservation leading to fewer electricity-production facilities (British Columbia, Ontario).

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[7] MacLaren Engineers, et.al., CCME National Task Force on Packaging: Phase I Final Report (Toronto: MacLaren Engineers et. al., 1989).

3.13 Conclusions

A clear message which flows from the above catalogue of regulatory, target-setting, and active public sector clean-up initiatives is that there is plenty of material for a early options identification process to work with.

In more specific terms, it is important to note that:

- the "command-and-control" model of regulation still predominates, although coupled with incentives in a few instances, as with the St. Lawrence Action Plan;

- while much valuable "front-end" work on the need for new science and technologies has been completed, the development of information to secure suppliers has not been nearly as active to date; the clean technologies theme is starting to emerge, but the demand for remedial approaches still predominates;

- there is an assumption in much of the needs assessment work that foreign technologies will be available and will be secured to meet priority Canadian requirements.

An early options project to accelerate work on critical science and technologies for the environmental industries could do worse than to take each regulatory initiative, profile its requirements, and then recast them as industry opportunities.

Based on the consideration of work to date, the most promising areas for Canadian science and technology activity would appear to be in relation to CFCs and the pulp and paper industry. In arriving at these choices, the reasons for rejecting other options are briefly as follows:

- a focus on chemicals management under CEPA simply involves too many substances to permit a focused development program to be undertaken;

- new automotive emission controls are likely to be developed by the large multi-nationals; while this in no way precludes smaller Canadian parts manufacturers from becoming involved, it means that the international dimensions of science and technology work her will be much more complex; there should be a close linkage between work on environmental science and technologies and the Automotive Industries Sector Initiative in ISTC;

- new standards for NOx and VOCs involve a great many initiatives; as yet a final plan has not be adopted by the CCME; some of the science and technology implications of the standards will be excellent candidates for a second round of the early options process; the chlorofluorocarbons are one of the VOCs to be regulated;

- much work has already been done on packaging science and technology from an environmental perspective; however, the early results on plastics in particular are not very promising; it would appear that more front-end work is needed before a truly early option could be developed;

- PCB destruction science and technology is already advanced in both Canada and the United States; science work on fully-acceptable replacements for PCBs would appear to have some distance to go;

- much has already been learned about the clean-up of contaminated sites through the U.S. Superfund Program; it would appear wisest to capture all of the available learning from that large-scale process before attempting independent Canadian efforts;

- both the St. Lawrence Action Plan and the Great Lakes Clean-Up Program involve many different types of environmental science and technologies; pulp and paper would appear to be one of the most important of the industries to be cleaned up;

- used tire disposal technology appears to be in reasonable shape already;

- provincial effluent standards apply to many different types of industries, among which pulp and paper is one of the largest and most visible.

An exclusive emphasis on the environmental science and technology implications of Canadian standards could risk a preoccupation with current priorities at the expense of those just on the horizon, and would ignore the wider international trends underway. Let us turn to this subject.

4. INTERNATIONAL REGULATORY INITIATIVES AND CLEAN-UP PROGRAMS

4.1 New Environmental Legislation and Regulations in the United States

There are seven major pieces of environmental legislation at the Federal level in the United States:

- o the Clean Air Act;
- o the Clean Water Act;
- o the Resource Conservation and Recovery Act;
- o the Federal Insecticide, Fungicide and Rodenticide Act;
- o the Toxic Substance Control Act;
- o the Comprehensive Environmental Response, Compensation, and Liability Act which creates the Superfund;
- o the Safe Drinking Water Act.

These generally establish national standards to control handling, emission, discharge and disposal of harmful substances. Programs may be implemented by the U.S. Environmental Protection Agency, now a Cabinet-rank agency, or else delegated to the states.

The greatest amount of change in the near future is likely to occur in the Clean Air Act, three competing sets of amendments to which are being debated in Congress. Industry and labour groups are attacking the proposal as a continuation of past "command-and-control" methods.

The Environmental Protection Agency has commissioned economic impact statements which show that up to $10 billion annually could be required to comply with the measures, by the year 2003. In all cases, technology-based standards are being envisaged.

Amendments were made to the Clean Water Act in 1987 to strengthen the EPA's enforcement authority.

Amendments have been made to other legislation listed above over the past four years to increase the capacity to enforce regulations on chemicals and toxic wastes.

Overall, the U.S. approach remains one of progressively tightening a regulatory net, usually in advance of Canada. Debate now centres around the need for more economic incentives, and for ways to encourage pollution prevention and clean technologies.

There may be opportunities for Canada in promoting the latter in the U.S. market, targeting the Northeastern Seaboard in particular.

4.2 Europe, 1992 and Environmental Regulation

The External Affairs Department is having a series of studies prepared on the implication of a single European market beginning in 1992. The first report, by Business International, notes that a number of measures under the new Single Market Program respond directly to environmental concerns.[8] These include: directives requiring environmental impact assessments for major investment projects, timetables for the gradual reduction of gaseous emissions from large combustion plants and motor vehicles, and civil liability for environmental damage regardless of negligence, incorporating the "polluter pays" principle.

Over 100 environmental directives are already in force across the Community, based on active involvement in such matters since 1973.

Here are some specific implications for Canadian industry which will likely call for development of environmental science and technologies:

- the directive on environmental impact assessment, in force as of July 1, 1988 requires that reports be prepared for all major investments in factories, power plants, highways, etc., and offers an opportunity for Canadian assessment services and remediation technology;

- the directive on large combustion plants, adopted in June, 1988 for implementation 1993 - 2003 calls for cuts of 60% in sulphur dioxide emissions and 36% reductions in nitrogen oxide emissions; Canadian experience with acid rain control technologies may be saleable to Europe;

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[8] 1992: Implications of a Single European Market, Part I: Effects on Europe (Ottawa: External Affairs Canada, 1989), p. iii.

- the directive on small car emissions calls for a 58% reduction in nitrogen oxide emissions, and 48% cut in carbon monoxide; while Canadian exports to Europe are unlikely to be significant, to the extent that Canadian standards are higher, they can be used to keep non-conforming European vehicles out;

- the directive on biotechnology emissions into the environment may affect marketing of Canadian biotechnology products in Europe.

4.3 Conclusion

The overall conclusion of the Europe 1992 analysis to date is that "[a]s other barriers to intra-Community trade are eliminated and the 'level playing field' becomes a reality, it is clear that differences in environmental protection will have an increasing effect on competition."[9] A similar conclusion would probably not be out of line in relation to the United States market.

It is interesting to note that while Canada currently has ten "environmental choice" products, in West Germany there are already 2,500.[10]

What appears to be needed in this field, before a full scan of international opportunities has been completed, is some institutional mechanism for those with unique Canadian science and technology to gain more rapid access to international markets. This possibility will be examined again in relation to the markets in Eastern Europe and the Third World.

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[9] Ibid., p. 104.

[10] Ibid., p. 105.

5. GETTING THE FEDERAL HOUSE IN ORDER

5.1 The Scale of Federal Operations

The Federal government is the largest single "business" in Canada, with expenditures of $125 billion and over 585,000 public servants and Crown corporation employees. It is the largest commercial landlord, and owns or leases 5.7 million square metres of office space. Its 70,000 buildings and facilities annually consume about 5.7 billion litres of water and 45 terajoules of heat energy, the latter costing over $500 million.

Further, Federal departments and agencies purchase 1,250 motor vehicles in a typical year, adding them to a fleet of over 23,000. These are among 17,000 different categories of consumer, commercial and industrial goods and services. The total value of such purchases from the private sector is over $10 billion.

The Federal government is the largest buyer of travel services in Canada at 288,000 reservations a year, and the largest publisher, with 9,000 printing jobs farmed out. It is also one of the largest purchasers of transportation fuels, at 28 terajoules annually, operating 800 ships and 150 aircraft in addition to its motor vehicles.

Clearly, all this activity has a measurable impact on the environment, and these figures do not even begin to include the wider effects of over 900 Federal programs intended to serve the needs of the population at large. Just as important as the direct impacts of Federal activities are the "demonstration effects" of its efforts, or lack of them, to achieve sustainable development.

5.2 Opportunities Arising from Particular Federal Activities to Get the Government's House in Order

Federal activities within the framework of getting its house in order are expected to cover about eighteen different areas, some as formal targets, and others as consequential activities.

Pursuant to the achievement of a reduction in federal solid waste disposal, there is a major opportunity for recycling companies. Cascades Paper is already involved in purchasing material from the "Papersave" program.

Such departments and agencies as National Defence are already seeking a reduction in transportation energy consumption and reduction in average fuel consumption of new vehicles they purchase. This creates an opportunity for suppliers of smaller vehicles, more energy-efficient models, and/or alternative fuels.

There is a good prospect for a target seeking reduction in overall building energy consumption, provided indoor air quality does not suffer. This should offer a major opportunity for consulting engineering and retrofit firms. Complementary steps may also be taken in achieving reduction in nitrogen oxide and volatile organic compound emissions, should a Federal-Provincialaction plan on the subject be adopted in the autumn of 1990.

A plan may also be adopted to reduce water consumption in office buildings and related facilities. This poses a major opportunity for consulting engineering and water equipment suppliers.

As well, the government may seek to procure approved "environmental choice" products, where available, creating a $300 - $500 million annual opportunity for suppliers of office products, and of comparable items to those in domestic use. Paper and re-refined lubricating oil are major items here.

Federal efforts to recover and reuse all CFCs in federal applications and to phase out use should create a major opportunity for suppliers of recycling equipment.

The government is committed to phase out PCBs, to ensure secure storage of PCB wastes, and to destroy PCBs as facilities become available. This is a $30 - $50 million opportunity for hazardous waste management firms and suppliers of destruction technology. There is also a major opportunity for suppliers of replacement chemicals in such items as lamp ballasts.

Pursuant to actions at the provincial level, the government is committed to eliminate or repair all leaking underground fuel storage tanks. This involves $100 million for the total program, including replacement, repair, and meeting a new code of practice.

Another Federal project is to clean up/stabilize contaminated sites such as old landfills on Federal lands. This is projected to cost $100 - $200 million, of which $25 million has already been allocated.

New Federal standards are being developed under the Canadian Environmental Protection Act for sewage waste from Federal plants. Meeting these standards will require procurement of $500 million worth of equipment and construction, with $180 million required for 12 largest plants. If Indian reserves are included in this process, there will be an additional $125 million of Federal procurement.

In addition, new Federal standards are being developed and promulgated for incinerators which will call for limited expenditure to retrofit existing plants, and perhaps eight new plants. About $25 million is involved for purchase of new incinerators and retrofitting.

New Federal standards for boilers are likely to produce about $10 million in business for the private sector.

Finally, a substantial number of departments and agencies are likely to conduct environmental reviews and audits of facilities and activities. This could create a market for perhaps $5 million annually in consulting services.

As part of the process of reviewing the environmental performance and compliance of Federal departments and agencies, additional land-use planning may be contracted out to ensure that new developments and existing uses are environmentally sound.

Various Federal laboratories and departments are seeking to implement "cradle-to-grave management" of chemicals which they use. This should offer a significant hazardous waste treatment opportunity.

5.3 Conclusion

The total estimated cost, regardless of source, of getting the Federal house in order could be $2.5 to $3.0 billion, of which 50% to 60% may already be budgeted in departmental capital plans, but may need to be accelerated, In calculating this cost, various recoveries have not been netted out.

For the selection of early options, it is best to divide the projects above into three groups:

- o those in which the Federal share of total annual activity is unlikely to be a major factor in the marketplace, and for which established technological solutions already exist;

- those in which the science and technology required by the Federal government are of such a complex or long-term nature that they are unlikely to be candidates as early options;

- those in which early procurement by the Federal government can have a major impact in establishing an industry or in developing new products and services for wider use.

In the first category are solid waste disposal, energy reductions in transportation and buildings, water management, replacement of underground storage tanks, sewage treatment upgrading, incinerator upgrading, and boiler upgrading.

Facing significant difficulties are PCB destruction and replacement and clean-up of contaminated sites.

Immediate opportunities appear to exist in relation to recovery and reuse of CFCs, management of halons, and procurement of Environmental Choice products. Of these, CFC recovery and reuse may have the edge as an early option for three reasons:

- departments such as DND are already seeking CFC-recovery and reuse technology, and are worried about the possibility for wrong choices;

- management of halons would appear to be mainly a matter of behaviour, rather than science and technology;

- it is not yet clear which of the Environmental Choice products will be acceptable for departmental use and require science and technology work.

6. MARKET OPPORTUNITIES AND CHALLENGES ARISING FROM THE CHANGING INTERNATIONAL SITUATION

6.1 The Scope and Impacts of Changes in the International Security Situation

In the last six months of 1989, and the first few months of 1990:

- Communist governments were swept from office across Eastern Europe;
- several regional conflicts, including those in Namibia and Nicaragua, were ended;
- institutions in the Soviet Union and Chile were democratized;
- major cutbacks in defence spending were announced in both Canada and the United States.

These changes are likely to free up resources to be turned to urgent environmental problems and to require much more environmental science and technology effort.

6.2 Reconstruction of Eastern Europe

The amount of environmental degradation evident to people in Eastern Europe, and their fears for the future of their own health and that of their children were a significant factor in the revolutions overthrowing Communist governments in Eastern Europe over the past six months. According to European Environment Review, Eastern European economies consume between two and four times as much energy for the same economic output. The consume substantially more fuel to yield the same amount of energy, and they show much higher rates of environmental and health damage.[11]

The likeliest early opportunity for Canadian action to enter the Eastern European market is in East Germany, which has large problems of its own. It has a framework for cooperation with West Germany in place. This is the "Basic Environmental Agreement" signed in June of 1987.

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[11] Vol. 2, No. 4 (December, 1988), p. 25.

The opportunity for Canadian entry exists because the West Germany capacity will likely be swamped with projects, the mark is to be made convertible later this year, and East German contracts with the Soviet Union are to be honoured. East Germany has historically been the source of much production machinery and equipment in the latter country.

It is therefore an ideal jumping off point for service to the eventual larger market in the rest of the region. The key difficulty, however, will be financing the work, regardless of currency exchange arrangements.

Early Canadian efforts to assess the need for industrial pollution control technology can be put into a context of cooperation on environmental science and technology, as they have been in relation to the Soviet Union. To the extent feasible, the Canadian approach should be that we will help these countries to move directly into clean technologies.

6.3 Development Assistance for and Trade with Third World Countries

Environmental considerations have been a significant factor in Canadian aid to developing countries. There are two overriding priorities in this regard, both arising out of the relationship between the environment and military security matters.

One is to link post-war reconstruction in Central America, Namibia, and elsewhere with low-pollution technologies. The other is to prepare now to respond in a major way to the environmental disaster created by war in the Sudan and Ethiopia.

6.4 The Defence Industries as a Sector Under Challenge

Canada has a major production and science and technology capability in the area of defence and security. One hundred and fifty establishments employing 26,000 people are engaged in development and production of defence electronics. Two hundred establishments and 53,700 people are involved in the aerospace industry, of which a substantial percentage is defence-oriented. Fifty-eight ship-building and ship repair establishments employing over 10,000, depend on defence contracts for a major portion of annual revenues.

It will be important to explore with the defence industries the extent to which their science and technology capabilities can be put to work on environmental problems. There are already clear overlaps in the field of environmental monitoring and surveillance.

6.5 Conclusions

In Eastern Europe and the Third World, Canadians have the potential to become "environmental peacekeepers" in the phrase of a recent Science Council report on environmental science and technology. To do so would appear to require greater co-ordination of Canadian marketing efforts.

The defence industries are clearly interested in exploring new science and technology opportunities which will utilize their existing strengths. They will require support, and potentially procurement activity, to manage a difficult transition successfully.

7. CHANGING CONSUMER PREFERENCES AND MARKET TRENDS

7.1 Market Drivers of Environmental Science and Technology

Some previous sections may make it appear that regulatory instruments of various kinds are the sole drivers of technological change requiring new environmental science and technology. This is not the case, although the importance of regulations in the short-term cannot be understated.

Appearing on the horizon, and now being actively considered by businesses are market forces, including the anticipated effects of environmental accidents on sales, the need to protect natural resources which supply raw materials, and consumer demand.

In the last connection, a recent issue of The Environmental Monitor indicates a significant majority of Canadians have changed their buying habits in relation to environmental concerns. The largest numbers of these people were either seeking out "environmentally-friendly" products, or else avoiding hazardous products.

The greatest market impacts appear to be among higher-income, better-educated, professionals, living in larger urban centres, especially in Ontario and British Columbia. In other words, prime marketing territory for all high value-added products and services.

7.2 "Environmental Choice" Products

Responding to these changes in consumer preferences, Environment Canada has initiated the "Environmental Choice" program, under which products which have been tested and reviewed by a board of advisors can receive an "Ecologo" seal of approval to be used in marketing.

This program has found both the process of setting standards, and of selecting products which truly are environmentally "more friendly" difficult to undertake. Many alternative products simply do not exist as yet, or are not produced in Canada.

Here are the classes of products which have passed through the review process:

- o re-refined oil;

- construction material made from recycled cellulose fibre;
- plastic products using recycled plastic;
- zinc-air batteries;
- water-based paints;
- fine paper from recycled paper;
- sanitary paper from recycled paper;
- miscellaneous products from recycled paper;
- newsprint from recycled paper;
- heat recovery ventilators;
- cloth diapers;
- composting systems for residential use;
- alternative fuels;
- reusable shopping bags;
- energy-efficient major appliances and products.

Of the above, only ten have received all necessary approvals to allow granting of the "Ecologo" to begin. Each is, however, an industrial opportunity for which the basic environmental analysis has been completed, but no specific environmental science and technology capability assessment.

7.3 Local Recycling Programs

In the United States, the National Solid Wastes Management Association has conducted surveys of consumer attitudes, showing that there is growing support for and participation in such programs.

In Canada, especially in Ontario, active municipal recycling efforts are already several years old, and are encountering their first problems. A key difficulty is in finding new uses for certain types of recycled materials, and in designing and engineering products to facilitate recycling.

So far, science and technology to address these issues has been left to the provincial bodies, in particular the Ontario Multi-Materials Recycling Corporation.

As in many instances noted above, there would appear to be a role for national leadership in technology development and diffusion.

7.4 Conclusions

The market-driven environmental industries are often well able to fend for themselves, and should be allowed to do so as much as possible. However, where another objective is able to be served such as regional development, or source development for Federal procurement, there would appear to be a case for ISTC to enter the field. The process of selecting which technologies to purchase would, however, best be driven by the needs of the user departments, rather than other considerations.

8. THE DIMENSIONS OF CHOICE

8.1 Selecting the Early Options from Among the Needed Science and Technologies

As can be seen from the foregoing analysis, in several respects, the problem facing ISTC is not that there is too little environmental science and technology, but too much. The needs pressing on a limited number of highly-qualified personnel are also becoming overwhelming.

At the beginning of the paper, we set out five major reasons for choosing amongst the available science and technology projects, both present and potential, in order to accelerate them.

These include:

- because the public expects the Federal government to bend its science and technology efforts to solve environmental problems;
- because the government has generated the need for the new technologies itself through its regulatory actions;
- because the variety of new demands on the environmental industries coming all at once requires concentration of highly-qualified personnel, research labs, and public funds;
- because Canada's international competitors among the developed countries are already providing major aid to their own environmental industries;
- because the consultation paper, A Framework for Discussion on the Environment has created the expectation of vigorous Federal action in relation to environmental technologies.

These reasons have been amply illustrated in the foregoing pages.

The question remaining to be addressed is: how does one select some science and technologies for particular attention, and perhaps for extra resources to accelerate efforts, when there are so many choices available?

While a definitive set of criteria is not feasible, the following appear to be helpful in sorting through the competing possibilities:

- which industries are most stressful to the environment?; it would make little sense to concentrate resources at the margins of environmental problems, even if some aspects of such an allocation were attractive;
- which industries are most trade-dependent, and therefore likely to be hit hardest by environmental regulations of other countries?
- which industries have capabilities and resources which are being freed up from other uses, and which could be turned to meeting the environmental imperative?
- which industries are most rapidly modernizing, and therefore offer the chance to combine environmental technologies with other new machinery and equipment?
- which industries are capable of producing either environmental technologies, or else technologies which complement them?
- which industries are already heavily engaged in Research and Development work, and would therefore be able to add environmental science and technologies to the portfolio of an existing capability?

8.2 Most Environmentally-Stressful Industries

The most environmentally stressful industries are:

- mining and smelting;
- primary metals production;
- organic chemicals production;
- petrochemicals production;
- pulp and paper production.

This selection is based on the combined consideration of effluents to water, airborne emissions, and energy intensity.

Of the above, pulp and paper appears to be receiving most public attention and probably has the largest investments to make.

8.3 Most Trade-Dependent Industries

The most trade-dependent industries are:

- o transportation equipment;
- o forestry products, including pulp and paper;
- o metals and alloys;
- o other machinery and equipment;
- o defence production;
- o agricultural products.

Trade dependency is based on the proportion of the total production which goes to other countries.

Pulp and paper appears to be under simultaneous price and offshore regulatory pressures.

8.4 Industry Resources Being Freed Up for Other Uses

As noted, a portion of the defence industry is not likely to be required for this purpose any longer. All other domestic industries appear to face normal market fluctuations.

8.5 Most Rapidly Modernizing Industries

The most rapidly modernizing industries, based on investment in new machinery and equipment, and incorporation of NC tools and robotics into production processes are:

- o pulp and paper;
- o primary metals;

- transportation equipment;
- machinery;
- electrical and electronic products.

Of the above, recent figures from Statistics Canada suggest that the largest investments are being made by pulp and paper.

8.6 Solution-Bearing Industries

While no industry is entirely environmentally-benign, there are industries and sectors which have lower environmental impact, and which could be "slipstreamed" by clean technology efforts. These industries are those which already help their clients to reduce environmental impact in the name of economic efficiency, which act as technology transfer agents and brokers, and which already conduct a major amount of Research and Development work.

The solution-bearing industries are concentrated in the machinery and equipment sector, and include:

- instrumentation;
- pulp and paper equipment;
- mining equipment;
- materials handling equipment;
- telecommunications equipment;
- food processing equipment;
- guided urban mass transit;
- surveying and mapping services;
- construction machinery;
- consulting engineering.

Most of these industries, except for those which are highly specialized, could be put to work to a greater or lesser degree on any early option which involves a major industrial sector. Selection of a portfolio of early options should seek to involve them through consultation, R&D support, and procurement.

8.7 Canadian Areas of Strength

The advanced industrial countries have been devoting a major amount of effort to the development of technologies to respond to new, higher environmental standards. There is no way that with limited resources, Canada could come from behind in many of the needed areas of Research and Development.

However, Canada already has a number of areas of technological strength which strongly support the clean technologies thrust.

These include:

- urban transit equipment and high-speed train rolling stock;
- telecommunications technology and consulting services;[12]
- energy conservation technologies for buildings;
- consulting engineering;
- aerospace;
- business machines and computer services;
- mining machinery;
- construction technology;
- selected chemicals and biotechnology products;
- selected defence electronics;

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[12] See for example, Robert V. Baser, "Communications Technology and Environmental Protection" (Vancouver: Globe '90 Conference Abstracts, 1990).

- wastewater treatment technology;

- primary metals technology.

While a good case for selection of any one of the above can be made, the Canadian strength which lies most clearly in the field of environmental science and technologies is wastewater treatment.

8.8 Conclusions

It can be seen that the Canadian areas of strength, the industries under pressure, and the solution-bearing industries converge in some key respects. Such industries as pulp and paper appear over and over, along with primary metals, transportation equipment and others. Of these, pulp and paper appears to make the fullest use of Canadian strengths in wastewater treatment technology.

9. SELECTION OF EARLY OPTIONS

9.1 Steps in Choosing Early Options

The basis for selecting early options science and technologies has been rather clearly established in the foregoing sections.

The selection process is advanced to the next step by providing answers to the following fundamental questions:

- what environmental science and technologies are going to be required regardless of what new environmental issues may emerge, and which problems may recede in importance?

- what environmental science and technologies are going to be required to meet Federal commitments which have already been made, and implementation of which has already been set in motion?

- what environmental science and technologies are going to do the most to defend Canada's traditional strengths, which is a core function of ISTC?

The answers to these questions are detailed further below. In brief, they are as follows:

- the resource-based industries are going to be under especial pressure from environmental regulations in the future, and will need "transitional" technologies of various kinds to bridge them into a period of clean-technology operations; the pulp and paper sector appears to face a uniquely difficult combination of circumstances;

- the defence industries are going to face difficult times, and are likely to begin a rapid search for alternative products, services, and markets;

- the process of getting the Federal house in order will proceed whatever happens on other fronts, because the commitments and standards to which it is related have already been largely established;

- the needs of Eastern Europe and the Third World are urgent, and are likely to grow more pressing as the pace of economic growth there picks up in the future;

- with the massive resources devoted to collection, interpretation and presentation of environmental science findings, and to the risk assessment which flows from them, it is inconceivable that tensions surrounding the presentation of environmental risks will disappear, or that the management of environmental information will become less complex; whatever happens on environmental issues in the future, there will be a need to manage technical information about environmental impacts and environmental technology alternatives.

9.2 Considerations in Promoting Clean Technologies for the Resource Sector

A major review of the attempt to implement clean technologies in OECD countries found that there were the following obstacles to their adoption:

- a market restricted to the establishment and modernization of plants, i.e., they cannot be readily adopted by plants which have already adopted earlier technologies, and do not need major retrofitting for other reasons;
- limited availability of clean technologies themselves;
- higher front-end costs, even if eventual operating costs are lower;
- higher technological, economic, operational and political risks associated with adopting a relative untried technology;
- lack of support from manufacturers of clean- technology machinery and equipment;
- regulations which may implicitly encourage add-on treatment systems;
- poor dissemination of technical information.[13]

One strategy for choosing early options projects would be to concentrate on industries which are already undertaking major modernization and expansion programs. In this way, clean technologies could be "piggy-backed" on other installation work. This leads to the selection of pulp and paper as a clear possibility.

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[13] Organization for Economic Cooperation and Development, The Promotion and Diffusion of Clean technologies in Industry (Paris: OECD, 1987).

9.3 The Other Sector Under Challenge: the Defence Industries

The range of defence-industry capabilities which can be applied to the environmental sector is substantial, including remote-sensing, selected process technologies, and "cross-over" technologies such as ship-board pollution control equipment.

9.4 Science and Technology to Get the Federal House in Order

The very practical considerations leading to selection of CFC-recovery and reuse technology have already been covered above.

9.5 Science and Technology Required in Eastern Europe and the Third World

The range of needs is so diverse that specific selections should probably not be made at this time. Instead, access should be facilitated for all those with Canadian strengths.

9.6 Interpretation and Presentation of the Findings of Environmental Science

There can be no effective movement on the whole range of environmental science and technologies if the interpretation and presentation of scientific findings does not relate to the needs of those charged with corporate decision-making.

This is likely to entail work to develop a greater dialogue on presentation of scientific results and on risk assessment between scientists, science writers, and industry. It may also call for work on information management technologies and systems. These are needed because of dangers that those taking tough industrial/ environmental decisions will be "swamped" by the scientific and technical information available, or will not be able to find what they require. As in the case of medical care and other rapidly advancing fields, information management has become a major organizational and technological problem.

Canada has important strengths in the interpretation of environmental science findings and in the development of management information tools which can be brought to bear on these challenges. Knowledge-based systems or "expert systems" can become an important tool for retrieving data needed to make environmental and operational decisions.[14]

9.7 Conclusion: Contribution of the Selection Process to Development of Criteria for Longer-Term Use

The method of identifying future drivers in the form of regulatory change, and the identification of key sectors and industries can be carried forward into the critical science and technologies selection process.

In particular, it will be essential to track the development of offshore environmental regulations which have direct implications for traditional Canadian strengths. As well, it will be important in considering longer-term science and technology options to recall the ISTC role of protecting Canadian industry, and not to become overly driven by the environmental industries agenda alone.

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[14] See Don Latham, "Information Transmission and Knowledge-Based Systems" (Vancouver: Globe '90 Conference Abstracts, 1990).

10. RECOMMENDATIONS FOR CLOSING THE LOOP BETWEEN ENVIRONMENT CANADA AND ISTC INDUSTRY ANALYSIS

Quite apart from the early options among environmental science and technologies, presented in this volume and elaborated further in Volume 1, it is important to "close the loop" between the industrial analysis carried out by Environment Canada and that which is within the mandate of ISTC.

ISTC should move immediately to convert information and industry consultation results assembled by Environment Canada as part of the regulatory process into scientific, technological and industrial strategy formats. Permanent links should be created to turn this into an ongoing process.

Items coming out of the Environment Canada process in 1990 call for science and technology relating to: transportation of hazardous wastes and toxic substances; PCB waste storage and treatment; methods for dealing with wastes and hazardous products; solid waste incineration technology; boiler-related pollution prevention and control technology.

Ozone-depleting substances and pulp and paper production processes are already covered by the proposed ISTC Action Plan.

A specific Industry, Science and Technology Canada approach to each of the initiatives envisaged by the "Green Plan" should be developed with the above items in mind.

The Department should begin preparing for its first presentation to the Federal government panel on environmental research and development. Once a consensus has been reached, the Action Report provided sas Volume 1 could for a basis for such a presentation.

ISTC should also develop a statement for the three national granting councils on priorities for fundamental environmental research at Canadian universities. The key shift required in this instance is for additional reporting of environmental effects and problems to basic analysis to underlie environmental solutions. This is illustrated by the "Green Plan" reference to a special program of research into application of economic instruments to environmental problems through a specialized university network.

ANNEX: THE ENVIRONMENTAL INDUSTRIES SECTOR INITIATIVE

Scope of the Sector Initiative

The intent of the Sector Initiative is to build a co-operative strategy to enhance the international com-petitiveness of Canadian companies producing environmental goods and services.

In its initial stages, the Initiative has focussed on collection and analysis of the information essential to a good understanding of the industry and its future needs.

Specific objectives are:

- to achieve measurable improvement in the statistical and intelligence base for purposes of industry analysis and policy formulation;
- to identify critical technologies and the requirements for their competitive application;
- to create a supply capability profile of the Canadian industry, in comparison with the international competition, for promising market segments;
- to identify and provide analysis of the domestic and principal international markets, their competitive environment and requirements for success.

Based on consultation and consensus with industry and other key stakeholders, the Initiative will move on to:

- develop an industry strategy covering the medium term;
- support a national industry association; and
- respond to urgent and obvious opportunities for industry development.

The Sector Initiative has a co-ordinating team and three working groups. The latter are focussed on:

- an effort to understand current economics and structure of environmental industries;

- a marketing effort for existing products, services, processes and technologies;

- an effort to identify and set priorities among new and emerging technologies which can be produced in the future, and develop support strategies for the science and other activities needed to develop them further, called "critical science and technologies".

Definition of "Critical Technologies"

The definition of critical environmental technologies is still very much in the formative stages. As an initial working definition, "critical technologies" are those which:

- can be produced in Canada or acquired and reproduced; and

- have the potential to be exported to fill world market demand; and

- are required to meet an urgent environmental need; and

- are required to enable industry to meet established government regulations or by consumers to allow them to function in ways less harmful to the environment; and

- have passed a technology assessment which assures their value and reliability.

Overall, critical technologies are those which will yield large economic and industrial payoffs in the future, either because they will produce a high added value or because they will yield mass-consumption items for consumer markets.

"Critical environmental science" is that which either defines the need for new technologies in more specific terms, or shapes their development.

The ultimate aim of the critical technologies exercise is to determine what, if anything, the Federal government should do in the future with its own programs of scientific research, taxation, regulation, technical assistance, subsidies, and information dissemination. Program examples set out in Section 1 in relation to Environment Canada regulations for 1990 are only some of the most obvious types of support.

The Critical Technologies Workplan

According to the Environmental Industries Sector Initia-tive Workplan for 1989-90, the aim of the Working Group leading this activity is to establish an operational definition of critical science and technologies and operational criteria for identifying and priorizing them.

As well, the team will identify and assess key drivers of technology, such as legislation, and investigate Canadian technological capabilities in comparison with the inter-national competition. The group will assess issues re-lated to demonstration projects, technology development and technology transfer. Finally, the group will consi-der how our competitors develop and transfer technology related to environmental products and services.

Under the new mandate of the Department of Industry, Science and Technology, work on critical science and technologies will integrate both perspectives into the traditional industry and marketing functions of prede-cessor departments. The team will conduct its activities by developing a consensus in close consultation with both users and producers of environmental technology.

There are eight major goals associated with the Critical Science and Technologies portion of the Workplan:

- To design the scope of the workplan for critical science and technologies;
- To establish a solid understanding of environmental research/technology activity, capability, future directions and prospects in Canada in comparison with our major competitors;
- To establish criteria for priorizing critical science and technologies;
- To investigate the potential for supporting possible "early options" projects;
- To identify and assess key determinants of science/ technology development with a link to market development;
- To understand the role of environmental demonstra-tion projects in technology and market development;
- To foster an understanding of technology development and transfer;

- To disseminate information which has been collected and analyzed on critical science and technologies.

In the Workplan, the "early options" project is described as a study scoping and identifying possible projects in Canada (e.g., St. Lawrence, Great Lakes) which may require clean-up prior to March, 1991. It would assess the technological solutions required and the Canadian capability to deliver the solutions competitively. Recommendations would be made on enhancing the competitiveness of potential Canadian suppliers.

The Role of ISTC in Relation to the Environmental Industries

The Department of Industry, Science and Technology plays a dual role in relation to environmental technologies. It is charged with increasing Canadian competitiveness in domestic and world markets.

In this context, ISTC may be called upon to oppose the adoption of certain technologies and to argue against regulations which call for them.

On the other hand, the environmental industries are like any other, and deserve Federal support -- information, brokering, R&D, international promotion -- to the extent that they can generate high-quality jobs and export earnings for Canada. The introduction of certain environmental regulations and technologies has promoted greater competitiveness as well.

The Environmental Industries Sector Initiative

The Environmental Industries Sector Initiative, and the Critical Science and Technologies component of this Initiative in particular, promise to help both private industry and the ISTC to break out of the pattern of reacting after the fact to environmental problems and the new regulations which they breed. It will do so in two main ways:

- by identifying science and technologies which have the effect of advancing both industrial competi-tiveness and environmental protection at the same time;

- by converting "costs to industry" into benefits and industrial opportunities for the environmental industries.