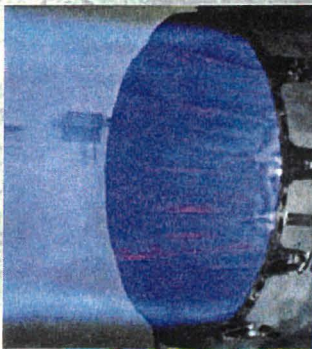




Industry Canada

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AN ANALYSIS OF MARKETS FOR CANADIAN ENVIRONMENTAL TECHNOLOGIES



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An Analysis of Markets for Canadian Environmental Technologies



March 1998

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Branch and Technology Partnerships Canada.***

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Environmental Affairs Branch
235 Queen Street, 7th floor East
Ottawa, Ontario
K1A 0H5

Tel.: (613) 954-3080

Fax: (613) 952-9564

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1.0 Introduction

Canada's environmental industry provides a wide range of pollution prevention and environmental conservation, control, protection, remediation and enhancement technologies. Its success in developing efficient solutions for its domestic customers will be critical not only to its own long-term international competitiveness, but also to the competitiveness of many other Canadian industrial sectors.

Domestic demand for environmental technologies is an outgrowth of several market drivers. These drivers include government action such as regulatory and policy measures, industrial market drivers such as compliance and liability provisions, infrastructure developments, environment and human health concerns and the search for efficiency. Many of the market forces at play in Canada are also present in global markets for environmental technologies. Recently, growth in the environmental industry has been clearly towards technologies which have a strong economic and environmental basis (i.e. eco-efficiency); help prevent pollution and, have a strong cost competitive advantage in regulatory driven markets.

This report provides a preliminary review and analysis of the environmental technologies market which was conducted by the Delphi Group in the fall of 1997. The analysis includes a consideration of the demand, supply and financing issues for these markets, and a roll-up of research and development (R&D) spending in the Canadian environmental technology industry.

The market for environmental technologies consists of a number of smaller, more defined market segments. Given this market reality, each market segment has been analysed in some detail. Two key points should be made about the analysis in this report:

1. *Market Numbers:* The production of Canadian and global market numbers and growth projections for environmental technologies is not based on exhaustive and complete empirical source data. This is because this type of comprehensive data simply does not exist. Market measurement and projection is based on the analysis of various geographic and segment empirical studies, and key informant responses, including:
 - Statistics Canada's 1995 Environmental Industry Survey, Preliminary Data;
 - U.S. Segment Surveys Produced by Environmental Business International;
 - a Study of Canadian Environmental Markets produced by Richard Miller and Associates Inc. (Norcross, Georgia);
 - U.S. and Global Environmental Market Studies of McIlvaine Company (Northbrook Illinois);
 - Global Environmental Market analyses produced by the GLOBE Foundation of Vancouver;
 - a number of environmental market segment and geographic studies published by the World Bank and its agencies;



- publications of the United Nations Development Programme and United Nations Environment Programme (UNEP);
- key informant responses and company activity and performance information;
- material from a range of environmental industry publications including Environmental Science and Engineering, Waste Age, U.S. Environmental Market newsletter, The Gallon Report and Recycling Times.

While the approach utilized to generate market figures is not statistically pure, it does have a substantial amount of validity due the corroboration from and cross-checking of multiple sources, and meets the test of investment analysis.

2. *Distinctness of Market Segments*: The market segments analysed are not mutually exclusive - there is some overlap between certain market segments. For example, there may be some overlap in projections for the Industrial Efficiency and Materials Recovery, and Energy Efficiency, Alternative Energy and Fuel Markets. The extent of this overlap is felt to be modest.

A Summary of Canadian and Global Environmental Markets, on a segment by segment basis, can be found in Schedule 1 in Annex. The Summary shows that the total Canadian environmental technology market is \$24,526 million. This is substantially different from the 1995 Statistics Canada Survey of the Canadian Environmental Industry. There are a number of reasons for this differential:

- there is a one year difference between market estimates (i.e. 1996 vs 1995);
- the Statistics Canada survey includes some environmental goods and services that are not included in this report, but does not include a number of market segments that are included here, notably: R&D, Energy Efficiency, Alternative Energy and Fuels, Construction and Facilities, and Industrial Eco-Efficiency;
- as a “first time survey” the Statistics Canada survey has likely underestimated the size of the market;
- some niche markets (e.g. GIS, Informatics, and infrastructure capital) appear to be underestimated in the Statistics Canada survey.

Each segment listed in the market summary will be discussed in detail in this report. The analysis includes a market summary, a discussion of demand and business prospects, market numbers, supply and competitive factors and financing issues.



2.0 Infrastructure and Industrial Water and Wastewater Markets

2.1 Water and Wastewater Infrastructure Markets

2.1.1 Market Summary

The municipal infrastructure market segment of water and wastewater technologies is the largest single component of the environmental industry. The domestic market has been growing marginally over the past five years, however, market development both in Canada and abroad is expected to be very substantial over the next decade.

2.1.2 Demand and Business Prospects

While market growth is encouraging, business prospects for environmental technology companies supplying water infrastructure markets will depend on a number of factors:

1. Companies will either need to have large scale operations and the capacity to compete in domestic and global markets, or have specific market niches based on proprietary technologies. Small scale companies will find the barriers in this market substantial.
2. Price competition will be fierce, especially as markets liberalize.
3. The market will increasingly seek out integrated technology solutions rather than sourcing individual components. This will be partly attributable to the emergence of private financing which will result in the adoption of build-own-operate approach to infrastructure development.
4. In Canada, demand for water conservation and efficiency technologies will grow rapidly as municipalities move towards full cost pricing regimes.
5. Both domestically and internationally buyers will value suppliers which include project financing solutions as part of their technology offerings. Companies would be well advised to partner with project finance brokers and sources of capital.
6. Water infrastructure regulations in all markets are moving towards performance in contrast to process standards. This will tend to foster more technological innovation since operators will not be bound by legislation to a particular technology solution. The trend to regulatory reform will on balance, however, be slow and gradual.
7. There is a move on the part of some municipalities towards ultra-violet (UV) and ozone treatment of water to reduce reliance on chlorine for purification.



8. Vexing treatment problems include: excessive algae production in water and effluent streams (a big public issue), the impact on ammonia of fish populations and habitats.

2.1.3 Market Numbers

Market activity in water infrastructure is on the upswing in all markets. Domestic markets are expected to grow at an annual rate of 4%, and global markets at a rate of 9%, until the year 2000. This trend is expected to continue into the next century. Schedule 2 in Annex contains a detailed set of market figures (note: this includes both infrastructure and industrial markets).

2.1.4 Supply and Competitive Factors

Supply of water and wastewater technologies is expected to be very competitive. Major international competitors include the U.S., U.K., France and Germany. Canadian water technology companies are in a position of technology comparative advantage in such areas as: UV disinfection, biosolids treatment, membrane technologies and application, and advanced oxidation. The sector is price competitive in aerobic and anaerobic wastewater treatment, water ozonation and sludge disposal. Canadian water technology companies are at a distinct disadvantage in large scale project development. U.S., U.K. and French companies are better positioned due to the existence of large companies which can help raise capital for major projects.

2.1.5 Financing Issues

Water infrastructure technology companies are well established. There are a few fair sized (i.e. \$50 million a year + earnings) companies, and a large number of smaller companies (in the range of 10-50 employees). Their equity position relative to most other segments of the industry is good. Share performance of traded companies has been superior to average return on investment on Canadian exchanges. These companies are, though, beginning to seek capital for three purposes:

1. International expansion and the establishment of operations in global markets. This is largely for working capital requirements.
2. R&D in new technologies or innovation of existing technology to keep ahead of the market.
3. Project financing to ensure that they can compete against foreign competitors.

Of these, the latter may be the most important to the competitiveness of the sector, and for the promotion of growth.



2.2 Industrial Water and Wastewater Markets

2.2.1 Market Summary

Market transactions in industrial water market over the past three years has been much more active than municipal infrastructure markets, both in Canada and abroad. Industrial pollution prevention efforts, eco-efficiency initiatives and regulatory changes, related to specific chemical groups, has driven demand. This trend is expected to continue and become stronger, especially as industries in emerging markets grow and capitalize new capital stock.

2.2.2 Demand and Business Prospects

Market growth in the sector will be very positive for the environmental technology sector. Demand, however, will be diversified on an industry by industry basis and market features will be dependent on a number of variables.

1. Increasingly, there will be two distinct elements to industrial water markets. The first will be towards the individual technology components (e.g. membrane technology). The second will be that the technology packaging and application will often have a specific industry focus. To be competitive, companies will need to ensure that integrated solutions are being supplied.
2. Rising water and wastewater charges in Canada will increase demand for conservation, reuse and recycling technologies on the part of major water users that currently source water from municipal infrastructure systems. The food products industry, in particular, consisting of 400 plants in Canada, is a major sector which will demand these technologies.
3. Similar to infrastructure markets, industries will increasingly seek out integrated technology solutions rather than sourcing individual components. This is because of greater out sourcing of operational environmental functions.
4. Industries will place a premium on new technologies which can address separation of toxic and hazardous pollutants from waste streams. The specific elements involved will vary by industry.
5. At this point supplier financing is not an issue in industrial markets, however, this may change for larger projects in new facilities.
6. Technologies for monitoring and data acquisition and processing are in demand because industries are moving to better reporting of releases and also need to identify liability situations to a greater extent than in the past.



7. Industrial water technologies are in major demand in Eastern, Western and Central Europe.
8. The automotive and manufacturing industries are seeking wastewater treatment technologies which de-grease, de-oil, remove metals and balance pH.

2.2.3 Market Numbers

Market activity in industrial water technologies is on the upswing. Domestic markets are expected to grow at an annual rate of 4%, and global markets at a rate of 9% until the year 2000. This trend is expected to continue into the next century. Market numbers are listed in Schedule 2 in Annex (note: these include water infrastructure markets).

2.2.4 Supply and Competitive Factors

Supply of water technologies to industry will depend largely on technological advantages and company/industry relationships. Price will be somewhat less important. Companies are placing greater value on environmental technology companies which can demonstrate that their products will meet the pollution prevention and treatment standards required.

Competition in this sector is fragmented - it will vary by industry or chemical class. Proven effectiveness, especially, in cases of particularly nasty pollutants will win in most instances. Canadian comparative advantages include: instrumentation and monitoring, remote sensing, membrane and ultra-filtration, and industrial application strengths in pulp and paper, minerals processing, fermentation, petrochemicals and manufacturing. U.S., German, Swiss and Japanese technology companies are stronger in the sectors of light manufacturing, chemicals, food processing (though not for the U.S. industry), dyes and intermediaries, pharmaceuticals, fertilizers and sugar.

2.2.5 Financing Issues

Financing issues for this segment are similar to the water infrastructure markets. Additional capital requirements for the industrial water and wastewater markets include the following:

1. R&D to introduce new technologies, particularly for the treatment of certain chemical agents in specific industrial situations.
2. Commercialization and international expansion of measurement, instrumentation, monitoring and remote sensing technologies.
3. Strategic alliances with global agents and partners to create a presence in growing global industrial markets.



3.0 Transportation and Industrial Air Pollution Markets

3.1 Transport Oriented Air Pollution Markets

3.1.1 Market Summary

Transportation air markets will be driven by domestic and global concern for local air quality, and can be expected to be affected by the actions to be taken by governments to meet climate change commitments under the Kyoto Protocol. Markets have been growing at a steady rate driven, in fair measure, by the solid automotive market over the past five years. Significant growth will be dependent on the degree of command and control or consumer action on issues such as smog and climate change.

3.1.2 Demand and Business Prospects

A number of factors will affect demand for air pollution control technologies:

1. The U.S. Clean Air Act has been a major driver for air quality improvement. If the U.S. government continues to introduce new clean air measures this will tend to benefit the industry.
2. Innovation in car design by the automotive sector in North America has a major impact on air markets during the past decade. While this was partially due to their interest in fuel efficiency to compete with imports, it has increased demand for catalytic converters and other control devices. It is likely that growth in this market will moderate and begin to plateau in North America. The growth markets in emerging economies in Latin America and Asia offer enormous potential.
3. Rising concern over human health risks from smog will increase pressure for governments to set stricter air quality standards, and will increase demand for air pollution control technologies. The recent move towards mandatory automobile emissions testing in Ontario and B.C. will create more demand for technologies.
4. Natural gas conversion tends to be limited to high mileage vehicles such as taxis and buses. This market is becoming saturated in Canada, but some potential exists for conversion in the U.S. Global markets are fertile.
5. Market forces in the air quality area intersect with alternative fuels and battery technologies. This is discussed further in section 9.



3.1.3 Market Numbers

Market activity has risen steadily in most segments of the transport-oriented air emissions market. Schedule 3 in Annex is a chart of market figures (note: this includes industry and energy-related market projections).

3.1.4 Supply and Competitive Factors

Canadian technology companies are fairly strong in the transport-related air pollution market, particularly in the automotive manufacturing sector. Many also have a competitive advantage in the area of catalytic converters.

3.1.5 Financing Issues

There is limited capital activity in the air pollution technology market. Canadian companies are doing reasonably well primarily due to their access to the large U.S. market.



3.2 Industrial and Energy Oriented Air Pollution Markets

3.2.1 Market Summary

Industrial and energy-related air pollution markets have not experienced the growth that was projected through the first half of the 1990s. Domestic markets struggled and most export markets grew gradually. The exception to this situation was in the U.S. where markets boomed. In 1995, the Environmental Business Journal reported clean air technologies activity of \$3.7 billion, 24 times larger than in Canadian markets. Markets over the next five years are expected to be more positive due to a number of demand factors.

3.2.2 Demand and Business Prospects

A number of factors will increase demand for air pollution control technologies related to industrial activity and energy generation.

1. The de-commissioning of nuclear plants in Ontario will mean greater demand for a range of thermal power generation technologies. Ontario Hydro is the largest spender in the sector. In 1995, it spent \$460 million on air pollution control equipment.
2. Rising concern over human health risks.
3. Industrial growth, tightening of regulatory controls and the installation of more fuel generating capacity in the energy sector should result in significant growth.
4. Indoor air technologies will be in greater demand in Canada, primarily due to an aging population which is more concerned about their health and is at higher risk for respiratory illness.
5. In Canada, the pulp and paper and minerals processing sectors have increased their demand for air pollution control technologies. Regulations to lower levels of Total Reduced Sulphur (TRS) in the former is increasing demand. Steel companies are taking voluntary action to reduce a range of emissions including benzene, hydrogen sulphide, and ammonia.
6. The U.S. market continues to be very promising due to numerous new rules and regulations associated with the Clean Air Act.
7. Odour and dust control in air emissions is becoming more important to industry and regulations, and communities adjacent to plants demand better air quality.



8. Automotive and manufacturing facilities (e.g. white goods) are seeking cost-effective technologies which reduce volatile organic compound (VOCs) releases from painting and surface finishing processes.
9. The pulp and paper industry, and the thermal energy sector, are actively seeking, and will pay a premium for, air or process technologies which eliminate PM 2.5 from air emissions. This problem is of particular concern in Canada's 47 kraft mills.

3.2.3 Market Numbers

Market activity is rising gradually in most segments of the air pollution technologies market. Major new international markets are developing, notably in the newly industrialized countries of Asia and Latin America. Schedule 3 in Annex is a chart of market figures (note: this includes transportation-related market projections).

3.2.4 Supply and Competitive Factors

Canadian technology companies are underrepresented in the air pollution market globally, and imports represent a high proportion of domestic market activity.

Canadian air technology companies have a competitive advantage in the areas of air emissions monitoring, gas and thermal incineration controls, and particulates. Air pollution companies in Canada are particularly strong in serving the pulp and paper, energy generation and minerals processing industries meet their regulatory requirements.

Canadian companies tend to be less competitive in such areas as Flue Gas De-Sulphurization (FGD), thermal and catalytic fume incinerators and scrubber and absorbers.

3.2.5 Financing Issues

There is limited capital activity in the air pollution technology market. Canadian companies are doing reasonably well, primarily due to their access to the large U.S. market.



4.0 Industrial Eco-Efficiency: Process Technologies and Materials Recovery Markets

4.0.1 Market Summary

Industrial eco-efficiency: process and materials recovery technologies offer the greatest potential for environmental technology markets. The strong economic gains these applications provide to other industries will drive demand for a diverse range of environmental technologies. In some instances, these technologies may be marketed as a specific industry-focused (e.g. for the steel sector) and/or efficiency technology. They have been included in this analysis because, in most instances, the environmental benefits of these technologies are a major decision factor for purchasers.

4.0.2 Demand and Business Prospects

The industrial efficiency market has rapidly grown through the 1990s, and is expected to boom over the next decade. The demand features of the market segment include:

1. A major focus will be on the efficient use of energy and water. In both industrialized and developing countries, price liberalization of these commodities will prompt industries to aggressively seek out solutions.
2. The global energy picture (beyond price) will gradually evolve to have a major demand impact on efficiency markets. The implications of the climate change agreement, and other factors will have an impact on demand.
3. Overall, gradually rising commodity pricing will lead to an increase in the value being placed on materials recovery. Companies are actively looking for new proprietary technologies, especially in the case of metals, and other expensive compounds.
4. Pollution prevention interest in closed-loop systems means that there is great demand for cost-effective technologies that can recover toxic and hazardous materials within the production process, notably if the chemicals/metals can be reused. In Canada and the U.S., this demand is being driven by the pollutant registries. A movement to enforce existing and strike new environmental regulations will drive markets in emerging economies.
5. Companies are willing to allocate capital investments to eco-efficiency technologies with some caution due to two factors. Firstly, the demonstrated effectiveness of newer or even more established technologies is often questioned as environmental technology companies have not been effective in providing economic performance assurances to



customers. Secondly, companies tend to expect a rather high internal rate of return for equity allocations. Technology companies must, therefore, demonstrate the full economic benefits of their products.

4.0.3 Market Numbers

Industrial eco-efficiency markets are very hard to quantify. There is no central source of market activity data for this market segment, and the diversified nature of technologies and industries makes it very difficult to aggregate market activity. It is, however, possible to track the technology and market factors for specific transactions. Schedule 4 in Annex gives examples of a number of Canadian eco-efficiency technologies and their associated markets. Estimates have also been listed in Schedule 5 in Annex for domestic and global markets for industrial eco-efficiency. Both narrow and broad markets are estimated. Narrow markets are ones where demand forces would not be present if environmental benefits were not produced. Broad markets opportunities yield environmental benefits as a side benefit of economically driven efficiency technologies.

4.0.4 Supply and Competitive Factors

Industrial eco-supply dynamics tend to have two types of technologies: ones which involve some competition and others which are technology-distinct (i.e. the technology is unique enough to create the market).

Canadian companies are competitive in a wide range of eco-efficiency technologies. Major eco-efficiency strengths include areas such as: wood waste, mining recycling, steel technologies, and solid waste. U.S., German and Swiss environmental companies are more competitive in the high-tech, manufacturing, chemicals, and food processing sectors.

4.0.5 Financing Issues

The industrial eco-efficiency area is a segment requiring a large amount of investment. Technology development and demonstration is costly, and requires patient capital. It is estimated that there is an annual appetite for a minimum of \$230 million in global investment.



5.0 Municipal and Industrial Waste Markets

5.1 Municipal Solid Waste and Recycling Markets

5.1.1 Market Summary

Municipal solid waste and recycling markets are in a state of major transformation. Domestic growth in the market have been relatively flat, and, for some segments, declining, especially in terms of technology. The Canadian market is characterized by a large number of equipment manufacturing and distribution firms which utilize proven waste management technologies.

The market is going through a period of consolidation as evidenced by mergers and acquisitions. Global markets show more growth, but the lack of effective market (i.e. price) mechanisms will mean that growth will also be moderate.

5.1.2 Demand and Business Prospects

Demand conditions include the following:

1. Diversion of solid waste into recycling markets continues to catalyse interest in technologies that can convert this waste into competitive secondary products. It is felt, though, that this market is starting to flatten out.
2. The amount of solid waste produced is rising by 1-1.5%, however, this is having minimal impact on technology demand.
3. There is some demand for innovative recycling technologies such as composting, however, the low price for these technologies, and associated services, does not tend to justify investment.
4. Fine paper recycling demand in North America will drive demand for technologies in this area, especially if technologies for mini-mills can be made cost-effective.
5. Demand for major recycled commodities fluctuates. Certain commodities such as polyethylene terephthalate (PET), copper, white ledger paper and red brass continue to do well. Prices for mixed office bales and steel cans are flat.
6. Demand may rise in the sector when municipal landfill supply begins to become short in major urban centres.



5.1.3 Market Numbers

Market growth is relatively flat. The market numbers in Schedule 6 in Annex include measurement of industrial solid and hazardous waste markets.

5.1.4 Supply and Competitive Factors

This market segment is considered very competitive with price being a major issue. Solid waste is moving towards becoming a true North American market, especially with the flurry of merger and acquisition activity. This market activity greatly influences technology demand. Canadian technology and equipment companies will need to develop strategic relationships with these well-financed conglomerates to be more competitive. It is the large waste companies which will move aggressively into, and be competitive in, foreign markets as the millennium ends. Rational waste pricing in emerging markets will likely be a consequence of a number of converging forces including: higher per capita GDP, rising urbanization, growing middle classes and a need for additional private investment in solid waste infrastructure.

5.1.5 Financing Issues

Financing in this market segment is closely related to cash flow. There is less longer-term investment capital in this area. Short-term financing is preferable as a risk mitigation strategy.



5.2 Industrial Solid, Hazardous and Toxic Waste Markets

5.2.1 Market Summary

This market segment has been growing steadily in North America, and is expected to grow rapidly in emerging and newly industrializing countries. The primary focus has been on hazardous waste. The market has a strong price driver, but in the case of particularly difficult and dangerous chemicals and substances, the quality of the technology is given a higher premium.

5.2.2 Demand and Business Prospects

Demand in this sector is quite evident in both industrialized and emerging markets:

1. Industrial waste generators are very concerned about the cost of waste disposal. Industry has made major efforts, where price drivers are prominent (i.e. where dumping prices reflect full cost), to divert solid waste away from landfills.
2. The Industrial, Commercial, Institutional (ICI) solid waste market is primarily serviced by private operators in North America. It is a price competitive market, however, landfills are often operated by municipalities with subsidized tipping fees.
3. Industry focus over the 1990s has been on the cost of toxic and hazardous waste treatment. Costs have risen due to a number of factors: a) restrictions on the use of incineration in some jurisdictions; b) more stringent regulations on the transport and disposal of substances; c) increased insurance and liability costs associated with hazardous and toxic waste; d) the strong emphasis the U.S. regulatory regime has placed on hazardous and toxic waste management due to rising public concern; and, e) the due diligence of financial institutions that are not keen (or charge a high price) for lending to corporations with major hazardous and toxic waste problems.
4. Corporations are actively seeking out technologies that can minimize the actual waste of hazardous and toxic waste, or ones which reduce disposal costs. Exceptions include substances like dioxin for which industry will pay a high premium for disposal.
5. Demand in global market is being driven by increased regulatory controls, International Financial Institutions' lending practices, importation of U.S. standards, public outcry due to major disasters (e.g. Bhopal), greater court-based enforcement, and rising concern of the middle class about their health.



6. One segment where the market is bullish is the disposal of medical waste about which the public is concerned. Some Canadian provinces do not allow the incineration of medical waste because of the potential harm of such things as dioxin emissions. Cost-effective non-incineration based medical waste technologies are in demand.
7. Industry is demanding "fail-safe" industrial waste systems which have 2-3 signals in case of variation from standard allowable emissions rates. They do not want to miss a "release" problem.

5.2.3 Market Numbers

Market growth is steady in domestic markets, and growing faster abroad. The market numbers in Schedule 6 in Annex include measurement of municipal solid waste and recycling markets.

5.2.4 Supply and Competitive Factors

Market supply forces vary depending on specific market situations.

1. The ICI solid waste market normally consists of 2-3 major haulers, and several dozen smaller haulers in any urban North American markets. Competition tends to be price and service quality based.
2. Technology is most important in the hazardous and toxic waste area. Companies tend to be quite concentrated in any given region due to the requirement for major capital investment, short and long distance hauling capacity, or specific technological advantages.
3. The Superfund driver in the U.S. has created enormous demand in the U.S. for hazardous and toxic waste treatment.
4. Canadian technology advantages tend to be in specific industries or for certain chemical classes such as polychlorinated biphenyl destruction, chlorine and phosphate control. The major Canadian strength in this area is in system and facilities design.

5.2.5 Financing Issues

There is demand from Canadian companies for capital in this market segment. It tends to be focused on technologies which provide solutions to specific industrial waste problems.



6.0 Construction, Facilities and Infrastructure Markets

6.0.1 Market Summary

The construction, facilities and infrastructure markets are not normally considered as an area for environmental technologies. However, the innovation in these sectors has seen an emergence of technologies which produce clear environmental benefits in many instances, or a point of marketing due to buyer interest. While some end users may be homeowners the actual market transactions occur between a series of industrial or institutional companies. This market segment intersects with other market segments such as alternative energy and air pollution, however, the nature of business activity is best appreciated from viewing transactions from a "build and development" perspective.

The construction/environmental market is being driven by: lower cost for recycled materials, consumer (industrial and resident) demand for healthy indoor environments, and more effective testing of facility operations.

6.0.2 Demand and Business Prospects

The following features characterize the market:

1. Corporations are becoming more concerned about the impact of working environments on workers. Superior indoor air quality, good ventilation, effective lighting (both in terms of energy efficiency and minimal eye strain on staff), noise control and risk exposure to hazardous substances are goals for many corporations.
2. The widespread recycling and reuse of materials has created a cost-effective supply of feed stock for construction materials through the application of technology. Recycled materials are often lower in price than virgin stock leading to good demand for a range of products. Companies are using: waste oil products to produce a very high quality roofing tile, lumber waste to produce medium density fibreboard, and PETs and other solid waste inputs to manufacturer number of extruded building products.
3. Sensing, measurement and information technologies are being used to improve the operation of facilities. This includes innovations such as the "smart building" (hard coaxial cable wired system with sensors for remote, or computerized indoor environments). Testing methods such as infrared technologies are being employed to assess the long-term performance of glazing technologies.
4. In terms of facility infrastructure, environmental technologies play a role in minimizing the environmental impact during both the construction and operating phases. In large part, this aspect of the market has been driven by environmental assessment



requirements, and lending provisions of new real estate development. For certain facilities (e.g. industrial parks) demand is a consequence of a number of environmental regulations of emissions.

6.0.3 Market Numbers

The market appears to be coming out of a period of slack activity. Infrastructure and real estate development is expected to drive demand in all segments of the market. The market numbers in Schedule 7 in Annex reflect estimated Canadian market activity. Comparable global data has not been found.

6.0.4 Supply and Competitive Factors

This can be both a price and technology competitive market segment. Price competition is a factor in the urban infrastructure segment. Several dozen Canadian engineering firms are competitive against foreign competitors provide technology in this area. Technological advantages are more important in the building envelope and indoor air environment segments. Technological advantages do, however, need to be capitalized and commercialized rapidly since R&D appears to be active. This is largely a North American market at this time. Exports to other markets have potential, but growth is expected to be modest. One of the major benefits of technology in this area is the large job multiplier.

6.0.5 Financing Issues

The financing emphasis in this segment is on R&D. Innovation is a major driver of price and/or technological advantage. Some capital is being placed by larger, non-environmental companies whose operating units have developed a technology. Smaller companies, whose technologies carry significant potential, are also present in the market segment.



7.0 Measurement, Instrumentation and Informatics Markets

7.0.1 Market Summary

Optimistic growth projections have been made for this market segment over the past decade. In fact, growth has been much more modest.

Measurement (i.e. Laboratory Testing and Analysis) market activity has been characterized by a slightly shrinking market. Instrumentation has experienced slow but steady growth. Informatics markets have yet to fulfill their predicted potential, but there are portents that the market is about to emerge in significant ways.

7.0.2 Demand and Business Prospects

The following demand factors are present in these markets:

1. The measurement market has been subject to peaks and valleys over the past decade. The introduction of various regulations in the 1980s led to an sharp increase in demand. As the market settled down and price forces came into play, there was a slight recession which led to smaller players exiting the market. Bad news has been compounded recently as governments have reduced public expenditures in this area. This has led to some mergers and acquisitions as firms seek economies of scale and market clout. Technology development in this market has been more positive, and newer measurement technologies have been a large reason for increased price competition in the sector.
2. The instrumentation market has experienced greater demand for public bodies and resource/manufacturing companies due to compliance requirements, and an emphasis on information to manage risk. Instrumentation technologies are also being applied in production systems to control waste and emissions.
3. The diverse informatics market, including remote and integrated sensing, and analytical, modelling and management software, has bumped along through the 1990s. The growth experienced in other markets has not been mirrored in environmental applications. Previously, companies have not bought into the need for sophisticated and integrated environmental software. This is clearly changing. Software companies are starting to prove the economic and technological effectiveness of their products. It would be unwise to say that this segment is poised for takeoff, however, significant growth appears likely.
4. GIS (Geographic Information Systems) is a hybrid technology family which falls within this market segment. There are a wide number of applications for GIS including a number of environmental uses such as resource management, emission monitoring,



and land use planning. Canadian GIS demand has been flat and is expected to decline. However, Canadian companies have built up a strong competitive advantage in terms of both price and quality in this market and have been aggressively entering foreign markets. One feature of Canadian competitive advantage is the expansion of the country's resource sector into foreign markets, and their tendency to utilize proven technology companies they know.

7.0.3 Market Numbers

The market is anchored by the laboratory testing and GIS segments. Software, remote sensing and other technologies are more modest in size. Growth, overall, in Canada will be flat to 2000. Global markets are expected to be more promising. A presentation of market numbers is found in Schedule 8 in Annex.

7.0.4 Supply and Competitive Factors

Competition in market segment vary. The laboratory testing market is very price competitive, and has been ruthlessly so over the past few years, forcing some firms to leave the sector or merge with others. This competition has tended to be an in-Canada factor, though some larger U.S. companies got into the game by purchasing companies to be Canadian subsidiaries. The GIS market is becoming more competitive on a global market as other countries boost their capacity. U.S. and U.K. firms tend to be the major foreign competitors. Software, remote sensing and instrumentation competition is based, in fair measure, on technology factors. Overall, Canada is a relatively strong competitor in global markets.

7.0.5 Financing Issues

Access to capital is clearly required in this segment as the competitive advantage is based on technology. Capital must be of the patient variety, which is rare. The technology development process in this segment takes between 1-2 years, but it takes an additional 2-4 years for the market to be penetrated. Uptake can be slow even for an effective technology.



8.0 Remediation Markets

8.0.1 Market Summary

Rosy days were predicted for remediation markets in the early 1990s. A series of public initiatives were launched as part of Environment Canada's Green Plan, and there was rising awareness that public lands had to be cleaned-up. It was also expected that there would be a "halo effect" from the Superfund legislation in the U.S. Over the last three years, however, projections have not materialized, and the market situation is different than expected.

8.0.2 Demand and Business Prospects

Demand factors include the following:

1. After initial efforts of the National Contaminated Sites Remediation Program in Canada were completed, no new allocation of funds has been made. While pressure is mounting for action, no new commitment has been made.
2. Clean-up of contaminated sites on public lands has suffered due to federal and provincial government efforts at deficit and debt reduction.
3. The private sector is demanding remediation services primarily due to compliance or capital borrowing factors. Drivers for remediation projects include environmental assessment, sale of property, facility expansion and employee/community health concerns.

8.0.3 Market Numbers

Market numbers in specific segments of the remediation are unavailable at this time, overall Canadian market size is estimated at \$215 million with a -3% growth rate and overall global market is estimated at approximately \$7 billion with a 4% growth rate to the year 2000 (Source: The Delphi Group, Secondary Source: GLOBE Foundation).



8.0.4 Supply and Competitive Factors

Technology plays an important role in remediation. Bioremediation, air sparging, sediment remediation, soil vapour extraction and thermal desorption and distillation are technologies which are applied as various technology solutions. Apart from niche opportunities, Canadian firms are competing against much larger, better resources and technological competitive firms in markets south of the border. There have been instances, however, where Canadian firms have beaten U.S. companies based on the price competitiveness.

8.0.5 Financing Issues

Financing activity is limited in the market.



9.0 Energy Efficiency, Alternative Energy and Fuel Technologies

9.0.1 Market Summary

The energy efficiency, alternative energy and fuels markets have been on a slow burn in Canada, and warmer in the U.S. and other international markets. Demand for energy efficiency technologies, particularly through the application of energy performance contracting and Demand Side Management (DSM) has been growing steadily in Canada, and is expected to grow substantially in export markets.

Alternative or renewable technologies have experienced poor market conditions in Canada (i.e. the lack of a level playing field against utility-based generation) with the exception of hydro power. Globally, renewable energy has great potential in select markets such as the U.S. and India, however, there have been some setbacks from the growth of the late 1980s and early 1990s. Demand for alternative fuels such as battery technologies and ethanol/methane appear to be on the rise in Canada, but the market has yet to takeoff yet. Market hurdles include: competitive pricing, thorough testing of technologies, mass production and distribution.

Overall, market conditions, and the potential of energy efficiency, alternative energy and fuels make it an important area of major Canadian investment and R&D.

9.0.2 Demand and Business Prospects

A range of market dynamics are influencing the energy market:

- Commitments to combat climate change in terms of pricing and technology demand;
- energy deregulation in Canada and the U.S., and the movement towards decentralized generation, including the associated access of producers to "wheel" power through existing transmission lines;
- the rising price of electricity, particularly in Ontario, which will drive demand for energy efficiency technologies and lower independent power;
- increasing concern about air quality which is already leading to greater demand for alternative fuels and battery technologies; and,
- trends in the automotive manufacturing sector to become more competitive through the application of new, more efficient internal combustion engines, emission controls, and associated technologies.



9.0.3 Market Numbers

Business activity in Canada for this segment is modest, but growing. Canadian installations are presently limited in renewable energy markets. Market activity is summarized in Schedule 9 in Annex.

9.0.4 Supply and Competitive Factors

Competitive issues are:

1. Canada is competitive in the application of energy efficiency technologies, particularly for northern climates on the basis of systems and applications engineering.
2. Canadian companies are becoming more competitive in energy efficiency technologies, however, those in U.S. and European countries, especially the Nordics, tend to be leaders in this area. Canadian companies are strong in the area of building systems and energy efficiency.
3. Canadian companies are generally not active in the renewable technologies market. With the exception of a few niche products, the European (Swiss, Danish, U.K.) and American companies are far ahead.
4. In the area of alternative fuels and energy, Canadian companies are fairly strong. We have a number of leading edge companies, and the science, engineering and information technology base to build on. This area carries significant potential for the country's environmental technology sector.

9.0.5 Financing Issues

Financing of energy efficiency is more of a project financing nature. This capital market is well developed and largely financed by insurance companies. There is a major need for long term, patient capital related to alternative fuel and energy technologies.



10.0 Environmental Technologies: Investment in R and D

Data on R&D investment in the environmental technology sector is limited. However, a number of sources of information regarding investment activity in the sector were identified:

the three Canadian Environmental Technology Advancement Centres (CETACS) monitor the investment requirements of their clients and track the actual capital placed;

the Canadian Venture Capital Association identifies the sectors which receive capital from its members on an annual basis;

annual reports and, notably, Corporate Environmental Reports, of private, non-environmental, corporations often contain information about decisions to allocate capital to the development of new technological process which have environmental benefits;

the Delphi Group's system for tracking the share price and capitalization performance of the 98 environmental companies which are listed on Canadian exchanges; and,

press releases and company announcements from environmental companies reporting their business development, including capital raising.

On the basis of these sources, the amount of investment on the part of Canadian environmental companies into technology R&D, commercialization and expansion was estimated at \$355 million for 1996. An estimated breakdown of investment by industry segment is found in Schedule 10 in Annex. This estimate equates to approximately 2.5% of earnings of environmental technology and equipment. While this estimate does not include R&D being conducted or funded by the public sector in Canada, including by research institutes such as the National Research Council, and, therefore, likely underestimates spending, this is a relatively low level of R&D investment for a high technology sector.



Annex

Schedule 1

Canadian and Global Environmental Markets Summary of Market Activity

Market Segments	1996 Revenue (\$millions)			
	Canada	Annual Growth to 2000	Global	Annual Growth to 2000
Infrastructure & Industrial Water & Wastewater Markets	\$6 630	4%	\$380 960	9%
Transportation & Industrial Air Pollution Markets	\$1 739	6%	\$37 178	10.5%
Industrial Eco-Efficiency Markets (Narrow Definition)	\$4 900	8%	\$113 000	12%
Municipal & Industrial Waste Markets	\$7 405	2%	\$175 750	5%
Construction & Facilities Markets	\$2 530	4%	\$53 130	6%
Measurement, Instrumentation & Informatics Markets	\$329	2%	\$6 074	3%
Remediation Markets	\$215	-3%	\$7 095	4%
Energy Efficiency, Alternative Energy & Fuel Markets	\$423	5%	\$7 255	5%
R&D in Environmental Technologies	\$355.1	3%	\$13 490	-4%
Total	\$24 526	3%	\$793 932	7%

Source: The Delphi Group

Secondary Source: Refer to Segment Schedules



Schedule 2
Canadian and Global Water Technology Markets

Market Segments	1996 Revenue (\$ Millions)			
	Canada	Annual Growth to 2000	Global	Annual Growth to 2000
<u>Water Technologies</u>				
Integrated Technologies	60	8%	3 550	10%
Separation Technology	175	3%	9 910	8%
Destruction Technology	90	3%	4 865	8%
Chemical Technology	25	3%	1 700	9%
Delivery Technology	310	5%	20 400	10%
Biosolids Technology	45	4%	1 965	5%
Chemicals	100	4%	6 440	11%
Contract Operations	80	8%	4 520	6%
<u>Water Services</u>				
Consulting	140	8%	8 435	12%
Design Engineering	130	9%	8 700	18%
Maintenance Services, Consulting & Engineering	90	5%	5 130	5%
Instrumentation Technology	30	5%	1 645	7%
Analytical Treatment	25	7%	1 300	5%
Water Treatment	2410	2%	158 760	9%
Waste Water Treatment	2920	5%	143 640	7%
Total Water Markets	6630	4%	380 960	9%

Source: The Delphi Group

Secondary Source: Mellvaine Company Scrubber/Absorber Markets



Schedule 3
Canadian and Global Air Pollution.
Control Technology Markets

Market Segments	1996 Revenue (\$ Millions)			
	CANADA	Annual Growth to 2000	GLOBAL	Annual Growth to 2000
Particulate Systems				
Fabric Filter Systems & Bags	174	4%	4 037	9%
Electrostatic Precipitators	202	5%	5 602	10%
Gas Treatment Systems				
FGD System & Parts	119	4%	3 864	12%
NOx Control Systems	84	6%	2 346	14%
Scrubber & Absorber Systems	197	3%	4 960	14%
Thermal Incineration Systems	69	3%	1 863	12%
Transport Related Technologies				
Catalytic Converters	580	6%	6 230	9%
NGV Systems	40	5%	700	7%
Vapour Recovery Units	20	2%	400	13%
Other Air Equipment & Services				
Air Consulting	118	6%	4 002	8%
CEMs & Stack Testing	104	-4%	3 174	6%
Indoor Air Technologies	32	7%		
Total Air Markets	1 739	6%	37 178	10.5%

Source: The Delphi Group

Secondary Source: McIlvaine Company Scrubber/Absorber Markets



Schedule 4
Process Technologies and Materials Recovery Markets

Process Technology	Product or Outcome	North American Estimate (1996-1997)
Microwave Process	Carbon Black	\$ 700 million
Wood Waste Resin	Medium Density Fibreboard	\$ 350 million
Wet Mill Filtration	Asbestos Long Fibre	\$ 420 million
Iron Plasma Process	Iron, Zinc, Lead	\$ 60 million
Carpet Recycling	Engine Air Cleaner Housings	\$ 75 million
Municipal Solid Waste	Extruded Products	\$ 20 million
PET	Numerous Plastic	\$ 1.4 billion

Schedule 5
Canadian and Global Industrial Eco-Efficiency,
Process Technologies and Materials Recovery Markets

Market Segments	1996 Revenue (\$ Millions)			
	CANADA	Annual Growth to 2000	GLOBAL	Annual Growth to 2000
Narrow Definition: Technologies which could not be in demand if environmental benefits were not present	\$4 900	8%	\$113 000	12%
Broad Definition: Includes Narrow Definition Technologies which produce some environmental benefits which are secondary functions in demand decision.	\$88 200	4%	\$203 000	9%



Schedule 6
Canadian and Global Municipal Waste and Industrial Markets

Market Segments	Estimated 1996 Revenue (\$ millions)			
	CANADA	Annual Growth to 2000	GLOBAL	Annual Growth to 2000
Waste Technologies				
Hazardous Waste Tech.	220	5%	20 240	8%
Organic Waste Tech.	35	1%	2 590	3%
Solid Waste Treatment	340	0%	25 840	3%
Recycling Tech.	110	2%	9 350	4%
Solid Waste Management				
Hazardous Waste Tech.	1230	5%	93 480	6%
Solid Waste Treatment	3070	1%	24 250	4%
Wholesaling of Scrap Metals	2400	2%	233 350	6%
Total Waste & Industrial Markets	7405	2%	409 100	5%

Source: The Delphi Group

Secondary Source: Waste Age, EBJ, Statistics Canada, Recycling News



Schedule 7

Canadian and Global Construction,
Facilities and Infrastructure Markets

Market Segments	Estimated 1996 Revenue (\$Millions)			
	CANADA	Annual Growth to 2000	GLOBAL	Annual Growth to 2000
Technologies				
Building Envelope Technologies	\$44	3%		
Indoor Environment Technologies	\$45	6%		
Repair Technologies	\$60	6%		
Urban Infrastructure Technologies	\$132	3%		
Services				
Design & Planning	\$349	4%		
Construction & Engineering (related to environment)	\$1900	3%		
Total Construction, Facilities & Infrastructure Markets	\$2530	3.5%	\$53 130	6 %

Source: The Delphi Group

Secondary Source: NRC, Statistics Canada, TAC, Industry Canada.



Schedule 8

Canadian and Global Measurement,
Instrumentation and Informatics Markets

Market Segments	Estimated 1996 Revenue (\$ Millions)			
	CANADA	Annual Growth to 2000	GLOBAL	Annual Growth to 2000
GIS	\$117	-2%	\$1875	4%
Laboratory Testing & Analysis	\$100	-1%	\$2900	2%
Remote & Integrated Sensing Systems	\$47	3%	\$179	3%
Modelling, Analytical & Management Software Products	\$32	3%	\$280	3%
Consulting Services	\$33	4%	\$840	4%
Total Markets	\$329	2%	\$6074	3%

Source: The Delphi Group

Secondary Source: IAETL, Future Technology Surveys, EBJ, Industry Canada.



Schedule 9

Canadian and Global Energy Efficiency,
Alternative Energy and Fuel Technologies

Market Segments	1996 Revenue (\$ Millions)			
	CANADA	Annual Growth to 2000	GLOBAL	Annual Growth to 2000
Technologies				
Energy Efficiency Technologies	\$71	4%	\$920	4%
Battery Technologies	\$115	9%	\$1210	7%
Renewable Energies (Solar, Wind, Biomass)	\$38	-0.04	\$3340	6%
Services				
Energy Project Development	\$38	3%	N/A	N/A
Energy Performance Contracting & DSM	\$68	2%	\$410	2%
Engineering & Scientific Services	\$93	1%	\$1375	N/A
Total Energy Markets	\$423	4.5%	\$7255	5%

Source: The Delphi Group

Secondary Source: EBJ. NRCan. CAN WEA, American Council for an Energy Efficient Economy.



Schedule 10
Private Research and Development Investment
in Canadian Environmental Technologies

Market Segments	Estimated 1996 Investments (\$ Millions)			
	Private Corporations (Non-Environmental)	Environmental Technology Companies (Equity & New Capital Raised)	Venture Capital	Total Investment
Water Technologies	5	37	N/A	42
Air Pollution Technologies	21	19	N/A	40
Process Efficiency & Recovery Technology	38	26	N/A	64
Solid Waste Management Technologies	3	13	N/A	1.6
Industrial Hazardous Waste Technologies	27	23	N/A	50
Construction Technologies	5	15	N/A	20
Measurement, Instrumentation & Informatics Technologies	14	24	N/A	38
Alternative Energy & Fuels	22	29	N/A	51
Remediation Technologies	4	18	N/A	22
Allocation Unknown		-	12.1	12.1
Total Investment	139	204	12.1	355.1

Source: The Delphi Group

Secondary Source: OCETA, CETAC West. Company Reports & Press Releases, NRC, Canadian Venture Capital Association.



