CANADA
HOUSE OF COMMONS

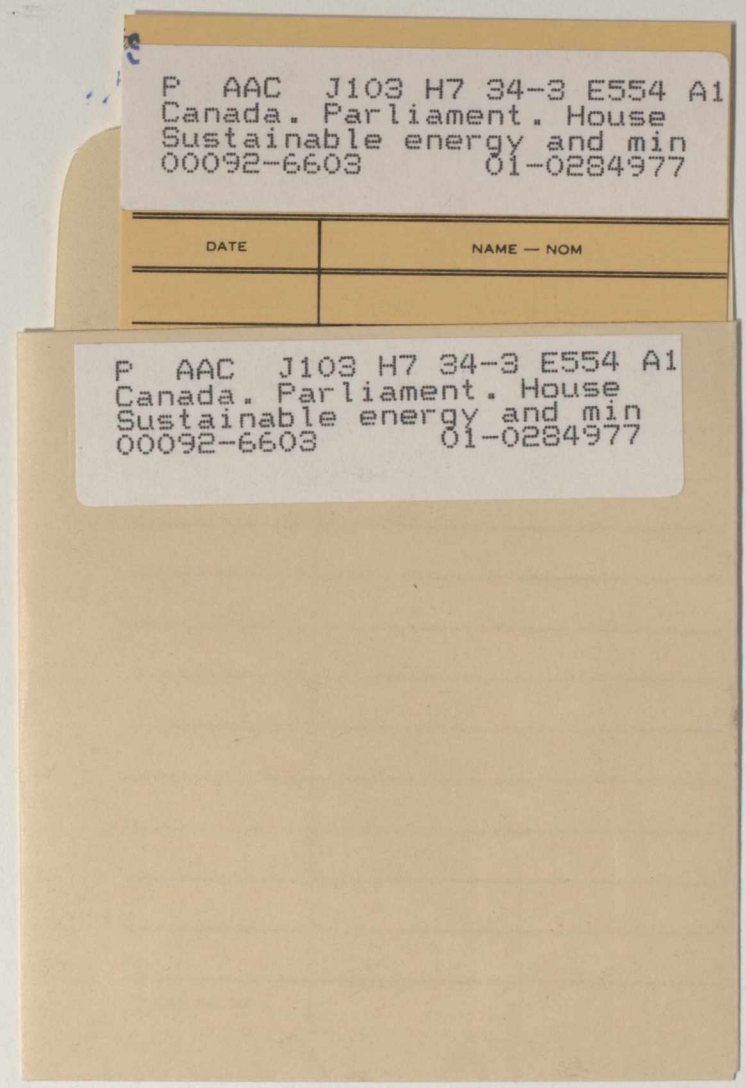
Sustainable Energy and Mineral Development:

A REALISTIC RESPONSE TO THE ENVIRONMENTAL CHALLENGES

STANDING COMMITTEE ON
ENERGY, MINES AND RESOURCES

Al Johnson, M.P.
Chairman

January 1993



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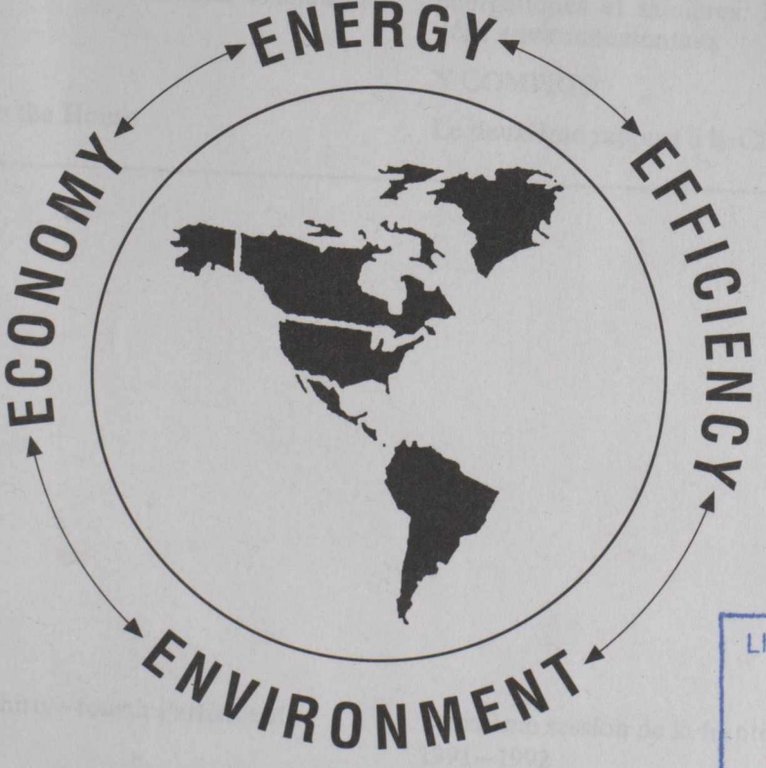

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CHAMBRE DES COMMUNES

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Le mardi 1er décembre 1992
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Président: Al Johnson

Minutes of Proceedings and Evidence of the Standing Committee on

Energy, Mines and Resources

Procès–verbaux et témoignages du Comité permanent de l'

Énergie, des Mines et des Ressources

RESPECTING:

Pursuant to Standing Order 108(2), a study on Sustainable Energy and Mineral Development: A Realistic Response to the Environmental Challenges

INCLUDING:

The Second Report to the House

CONCERNANT:

Conformément à l'article 108(2) du Règlement, une étude sur le développement durable des ressources énergétiques et minières: Des solutions réalistes aux défis environnementaux

Y COMPRIS:

Le deuxième rapport à la Chambre

Third Session of the Thirty–fourth Parliament, 1991–92

Troisième session de la trente–quatrième législature, 1991–1992

Members of the Standing Committee on Energy, Mines and Resources

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Clerks of the Committee

Stephen Knowles
Nancy Hall

Committee Researchers

Peter Berg
Lynne Myers

Consultants

(See Appendix A)

Third Session of the Thirty-fourth Parliament

The Standing Committee on Energy, Mines and Resources has the honour to present its

SECOND REPORT

Pursuant to Standing Order 108(2), the Standing Committee on Energy, Mines and Resources undertook a study on Sustainable Energy and Mineral Development: A Realistic Response to the Environmental Challenges. After hearing evidence, the Committee has agreed to report to the House as follows:

ACKNOWLEDGEMENTS

This Report could not have been completed without the input of many people. On behalf of the Members of the Committee, I would like to thank the Clerks of the Committee, Stephen Knowles and Nancy Hall, and the staff of the Committees Directorate, for coordinating the Committee's meetings and the organization of our work. The Research Team of Lynne Myers and Peter Berg, ably supported by Christine Jodoin, did a tremendous job of identifying witnesses and consultants who provided the Committee with valuable substantive input. In addition, they did an excellent job of preparing background notes, coordinating the input of consultants, witnesses and briefs for the Committee and drafting the Report.

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EXECUTIVE SUMMARY

When the House of Commons Standing Committee on Energy, Mines and Resources began its study of sustainable energy and mineral development, its intentions were clear. Representatives from the various energy and mineral sectors were requested to provide the Committee with what each industry believed to be a realistic response to the many pressing environmental challenges it now faced, and what the cost to them of such a response might be. The Committee would then issue a report to Parliament on how industry was planning to meet its current environmental goals and commitments.

The Committee did receive a substantial degree of information on industry's considerable historical contributions to reducing its impacts on the environment. This material is organized by sector in Chapters 5 to 15. Yet firms and industry groups were largely unable to provide a clear and precise response to the Committee's specific objective as stated above. For the most part, industry argued that the task set by the Committee was an impossible one to complete owing to the lack of a reasoned and ordered federal policy on the environment, one which would ideally be formulated from the results of a broadly-based consultation and decision-making process.

It soon became obvious to Committee members that the focus of the investigation, and subsequent recommendations, would have to shift from what industry's future response might be, to how governments could improve their environmental policy framework to ensure that such a response would be both environmentally effective and affordable. The Committee has concluded that the existing process of environmental policy-making needs to undergo a thorough revision. There is an urgent need to make changes in the following areas:

- The government's consultation and decision-making process needs to become more open and transparent, with greater emphasis placed on cooperative multi–stakeholder participation. Any strategy designed to meet environmental goals must involve Governments and stakeholders working closely together;
- The many environmental policy initiatives contained in the government's Green Plan need to be priorized according to the relative severity and urgency of the corresponding environmental problems;
- Emphasis needs to be placed on assessing the economic impacts of various environmental policy measures;
- Environmental regulation and legislation should be harmonized throughout the country and improved where possible; and
- Greater reliance should be placed on market-based measures in the formulation of environmental policy.

During the Committee's hearings, considerable attention was placed on two other important issues: the enhancement of opportunities in the area of energy efficiency, and the issue of global climate change. The Committee is convinced that for Canada to adequately

achieve its environmental goals, a determined effort to improve the efficiency of energy use will need to be undertaken. At the same time, we must continue to make abundant and cheap energy our competitive strength. We should not load onto the energy and mineral industries punitive policy instruments which would put these natural advantages at risk. The Committee has therefore concluded that the federal government should undertake to devise innovative solutions to achieving energy efficiency gains, measures that would provide financial rewards to efficient energy users.

Finally, one of the important thrusts of the Committee's Report is that global problems really do require global solutions and global accounting. Nowhere does this statement apply more than in the case of global climate change. Steps taken abroad to mitigate greenhouse gas emissions are often more environmentally and economically effective than domestic action for a highly energy intensive, relatively high-efficiency economy such as ours. In the Committee's view, every effort should be made to satisfy domestic environmental objectives by implementing cost-effective measures which would increase the efficiency of energy production and use at home. Indeed, the Committee believes that significant competitive advantages can accrue by keeping Canada at the leading edge of technology development. At the same time, however, countries in Canada's position should be permitted to receive credit for international action if such action leads to a lessening of what is essentially a global problem.

LIST OF RECOMMENDATIONS

Recommendation no. 1

That the federal government adopt the following set of principles governing environmental policy formulation and implementation. These would specify that, as a minimum,

(a) All stakeholders, including environmental groups, should be consulted in an effective manner, both when establishing environmental objectives and when formulating policies and action plans (cooperation among stakeholders is of fundamental importance to sound policy-making);

(b) Implementation of responses to environmental challenges should be priorized according to the relative scale and urgency of the challenge posed;

(c) Action to meet environmental challenges should be based on a scientific understanding of the issue in question;

(d) Environmental and economic priorities should be integrated, through an assessment of the total costs and benefits (both economic and social) of potential environmental policy and including assessing the consequences of not implementing such policy;

(e) Environmental regulation and legislation should be harmonized across Canada, and improved where possible;

(f) While the full array of fiscal and regulatory policy instruments available to governments should be kept in mind when determining appropriate responses to both single and clustered environmental challenges, market forces should be relied upon to the extent possible. (This will provide industry with greater flexibility with which to develop cost-effective responses to environmental problems.);

(g) Before negotiating international agreements on the environment, the federal government should consult with stakeholders to ensure that due consideration is given to the maintenance and enhancement of Canadian industry's international competitiveness. (Pages 135-136)

Recommendation no. 2

That the federal government establish ongoing processes of multi-stakeholder consultative decision-making to assign priority to the environmental issues identified; to anticipate problems accompanying the implementation of proposed environmental programs; and to arrive at realistic solutions including clear targets and timetables to properly specified environmental problems. (Page 138)

Recommendation no. 3

That the federal government examine the process used to develop the Clean Air Strategy for Alberta as a model for improved decision-making. (Page 138)

Recommendation no. 4

That the federal government devote greater funding to its environmental budget for scientific analysis of energy-related environmental concerns. (Page 141)

Recommendation no. 5

That the nationwide SO_2 emissions ceiling proposed in the Green Plan be imposed in Western Canada only after the need for it in that part of the country (west of Manitoba), is scientifically established and only after consultation with industry. (Page 141)

Recommendation no. 6

That the federal government take steps to ensure that the NOx/VOCs Management Plan of the Canadian Council of Ministers of the Environment be implemented in a manner that will be cost-effective, where possible, and provide for real environmental benefit within targeted areas. (Page 141)

Recommendation no. 7

That the federal government, in conjunction with environmental groups and all the major stakeholders in the energy and mineral sectors, and with the co-operation of the provincial and territorial governments, undertake a full energy cycle analysis of environmental impacts of the various energy sectors. (Page 142)

Recommendation no. 8

That the coverage of this study extend to all stages of the energy cycle for all energy sources, both conventional and alternative. (Page 142)

Recommendation no. 9

That the federal government, when introducing major environmental initiatives, be required to perform a detailed assessment of the following:

(a) **the environmental benefits and costs of both the proposed initiative, and of not proceeding with the initiative;**

(b) **the economic costs and benefits (including compliance costs, employment effects and the impact on regional and international competitiveness) of such action to the industries directly affected, as well as to other industries which may be affected.** (Page 143)

Recommendation no. 10

That cost-benefit analyses of the sort proposed in Recommendation no. 9 be made public for review and comment, prior to implementation of the environmental initiative in question, and that ample time be accorded for public input. (Page 143)

Recommendation no. 11

That the federal government, in conjunction with its study of the full fuel cycle environmental impacts of energy and mineral activity (Recommendation no. 7), attempt to assign a dollar value, where possible, to the environmental damage, and render public a comparative assessment of the study results for all energy sources studied. (Page 144)

Recommendation no. 12

That the federal government establish an interdepartmental coordinating committee on environmental regulation, with Environment Canada taking the lead role, which would have as its main objective the ongoing implementation of regulatory coherence as new regulations are developed. (Page 146)

Recommendation no. 13

That the federal government publish a guide to regulations affecting the energy and mineral sectors, providing a comprehensive list of the regulatory instruments in place, and urge provincial governments to do likewise. (Page 146)

Recommendation no. 14

That a comprehensive study be carried out of the cumulative effects of the entire federal environmental regulatory system, including an examination of both its environmental benefits and economic costs and benefits. (Page 146)

Recommendation no. 15

That the federal government adopt a more flexible approach to the regulation of environmental issues, with a full investigation of all regulatory options being done before regulations are set. (Page 148)

Recommendation no. 16

That the regulatory system be improved to foster innovation, and adjusted where regulations are found to be redundant or unnecessary. (Page 148)

Recommendation no. 17

That the government undertake to consult widely on the use of economic instruments with all major stakeholders, including environmental groups, by means of an improved decision-making process (recommended above), and implement a realistic action plan derived from the process. (Page 149)

Recommendation no. 18

That the federal government set Canada on a new course of action for its greenhouse gas emissions strategy by convening a series of consultations with all the major energy and environmental stakeholders to discuss the global climate change issue

and the environmental and economic implications of various implementation measures, with the federal government then deciding on a detailed action plan. (Page 153)

Recommendation no. 19

That as soon as possible the federal government provide stakeholders with a discussion paper on the potential costs and benefits of alternative strategies geared to achieving reductions in greenhouse gas emissions. (Page 153)

Recommendation no. 20

That the federal government seek a global commitment to a reduction, to be achieved by coordinated global efforts, of total global, anthropogenic greenhouse gas emissions by 20% from 1990 levels by the year 2005. (Page 154)

Recommendation no. 21

That, to help meet any commitments reached as part of any future global climate change convention, the federal government support proposals to facilitate Canada taking global action and receiving international credit for this action, such as contributing, financially and through technology transfer, to emissions reduction efforts in other countries. (Page 154)

Recommendation no. 22

That the federal government undertake a comprehensive assessment of the impact which its fiscal regime (including subsidies and taxes) exerts on the various energy sources, both renewable and non-renewable. (Page 155)

Recommendation no. 23

That using an improved decision-making process (see Recommendation no. 2), the federal government develop and set targets and timetables for reducing Canadian energy consumption where appropriate and feasible and for increasing the share of domestic energy production accounted for by renewable energy technologies. (Page 156)

Recommendation no. 24

That the federal government initiate renewable energy resource assessments in those sectors or jurisdictions where these have not been adequately compiled. (Page 156)

Recommendation no. 25

That the federal government increase support for basic research in alternative energy development and establish mechanisms to funnel financial resources to the developers of renewable energy technologies. (Page 156)

Recommendation no. 26

That the federal government assign a higher priority to energy conservation and efficiency and to reducing demand in its energy planning and policy decision-making. (Page 160)

Recommendation no. 27

That the federal government, in conjunction with its provincial counterparts and in consultation with other major energy stakeholders, devise innovative solutions to achieving energy efficiency gains. These would be tailored to providing firms and consumers with monetary inducements to use energy in a more efficient manner. (Page 160)

Recommendation no. 28

That the federal government, in conjunction with provincial governments and after full consultation with all interested parties in order to help avoid potential land use conflicts, complete an early identification of proposed park boundaries. (Page 161)

Recommendation no. 29

That the federal government re-allocate its energy R&D budget, devoting a significantly larger share to environment-related research, and to research in the renewable energy sector and energy efficiency and conservation. (Page 162)

Recommendation no. 30

That the federal government target its R&D expenditures on Canadian leading-edge technologies, where possible without selecting individual firms as "winners". (Page 162)

Recommendation no. 31

That the federal government place greater emphasis within its export development programs on transactions for transferring to developing countries technologies designed to mitigate environmental harm. (Page 163)

CHAPTER 1

INTRODUCTION

When the House of Commons Standing Committee on Energy, Mines and Resources launched its review of sustainable energy and mineral development, its aims were clear. Increasing environmental demands from both the public and government, such as the demand for a commitment to stabilize greenhouse gases, were prompting the energy and mining sectors to pay greater attention to measures to provide for environmental improvement. The Committee wanted to discover first-hand from each of the industries involved, what would represent a realistic response to current and emerging environmental challenges. For this we needed to know the impact that meeting these environmental demands would have on the industries and, in particular, on their competitive standing. Armed with this information, we could then determine the economic limits to federal environmental policy-making.

Considerable emphasis was placed on the need for realistic solutions to the various pressing environmental problems confronting Canadians, given the importance of balancing any actions taken domestically to preserve and protect our environment, with the equally important need to maintain our competitiveness and ensure our economic prosperity. The Committee is of the view that the public debate over environmental concerns has often regrettably not been balanced, and that the important economic considerations associated with environmental action ought to be given the attention they deserve, both by policy-makers within government and by other Canadians.

In our view, sustainable development, as it relates to the energy and mining sectors, involves continuing with desired levels of industrial and economic activity while at the same time ensuring that the environment is protected from irreparable damage. There is no essential contradiction between these two goals. Indeed, as the final report of the Brundtland Commission put it: "The common theme throughout this strategy for sustainable development is the need to integrate economic and ecological considerations in decision-making. They are, after all, integrated in the workings of the real world." Canadians are by and large united in their desire for a cleaner environment; yet Canada's energy and mining industries are critically important to the success of our overall industrial and economic performance. We cannot afford to load these industries with unrealistic environmental requirements that would impose onerous economic costs. Finding the appropriate balance between environmental policy and a realistic contribution by industry to environmental goals was precisely the Committee's objective.

Given that the energy and mineral sectors each exhibits unique development patterns with unique environmental effects, it was considered appropriate that the Committee adopt a sectoral approach for its review. Selected groups in each of the energy and mining sectors (coal, oil, natural gas, mining and smelting, hydro-electricity, nuclear power, alternative energy sources, and energy efficiency and conservation) were invited to co-ordinate a submission to the Committee. These groups were encouraged to consult widely within their respective

sectors to ensure that a broad range of points of view were addressed in the ensuing brief. Once submitted, these briefs were made public and reviewed both by consultants designated by the Committee and by potential intervenors. One week was set aside to assess each energy source's contribution to environmental progress.

As mentioned above, the initial scope of the Committee's investigation was quite limited. It was not our intention to choose which individual energy sources were preferred from an environmental perspective, or which should be eligible for government support. Several presenters before the Committee argued that it is not in Canada's best interests for the government to try to select winners; rather it should strive to maintain a flexible and diversified energy system. It remains the Committee's view that the preservation of such a system represents an optimal policy objective.

With this in mind, the associations selected to represent their industries were each provided with a set of specific questions designed to elicit information on the major environmental challenges they face, how they hope to cope with these realistically (from both a technological and financial point of view), and how government policy could be adapted to facilitate and enhance industry's response.

At the outset, the Committee was confident that the questions posed to industry and the sector-by-sector structure of the hearings would prove to be useful in soliciting specific and detailed information on how industry could address environmental concerns. To a large extent, we thought that industry would have already delved deeply into this question, and would be ready to share information with us.

Unfortunately, we were wrong. Apart from isolated submissions, detailed information on cost-effective technological options and the costs to industry of responding to environmental initiatives was not forthcoming. Instead, the message in most of the submissions seemed to be that efforts to evaluate what such a response would be and what it might cost the industry were in their infancy. Governments had not done an effective job of priorizing their environmental initiatives and had not assessed the economic impacts of imposing environmental measures, thus rendering it difficult for the industries to determine a realistic response. Specifically, the federal government had not set out fully how its policy on atmospheric emissions would be implemented.

It became quite obvious to us that the thrust of the evidence provided had switched from how industry could best respond, to how governments could intervene more effectively when establishing and implementing environmental policy. Our report, out of necessity, reflects this shift in emphasis. While we are hopeful that our deliberations on this important issue have prompted industry participants and government to redouble their efforts to assess and answer our challenging questions, we are unable to put forward as comprehensive a statement as we would have liked of each industry's ability to respond to environmental demands. Instead, the Committee's recommendations are focused on the steps that government can take to improve the effectiveness of environmental policy-making. A positive response to this report by the federal government, it is hoped, will go far to assist industries in responding more effectively to their particular environmental challenges.

The Committee's review of sustainable energy and mineral development is set out as follows. Chapter 2 is devoted to an elaboration of the importance of the energy and mineral industries to the Canadian economy, and to their current financial state. Canada's position as a small, open economy highly reliant on value obtained from its natural resources and a price taker in world commodity markets, requires that it keep a vigilant eye on its cost-competitiveness.

Chapters 3 and 4 present, in broad terms, the environmental challenges faced by the energy and mining industries, and an overview of how environmental questions should be integrated with economic concerns. The concept of sustainable development is treated from a natural resource perspective, and the Committee outlines its views on what a realistic response to environmental issues should comprise.

Chapters 5 through 10 are sector-specific in that they present the evidence from the conventional energy industries on past environmental challenges and responses as well as their efforts to address today's environmental issues. While this information is often general in nature, it nevertheless delineates the environmental concerns that predominate in each sector, as well as the technologies currently being developed. These chapters provide information on some or all of the following topics:

- the specific environmental challenges faced by each industry;
- the industry's realistic response to each challenge;
- current and emerging technologies that can be employed, as well as general information on their costs (where available); and
- the potential for technology exports.

Five chapters (11 to 15) are set aside to examine the important contribution that selected alternative energy sources, as well as energy efficiency and conservation of conventional sources, can make to reducing pollution. These energy options are viewed by the Committee as important elements in Canada's energy future, and, as we note below, deserve greater encouragement.

The report concludes with the Committee's views and recommendations on government environmental policy as it relates to the energy and mining sectors of the economy and the process by which this policy is formulated and implemented. Industry was virtually united in its call for a more precise ranking of environmental priorities and for an improved decision-making process which would bring all the key stakeholders to the table. Much was also heard on the need for a more streamlined, yet effective, environmental regulatory system, and for an examination of more cost-effective modes of intervention, such as the use of economic instruments.

Finally, in a previous report tabled in the House of Commons on 24 February 1992, the Committee presented its views to the federal government regarding what the Canadian negotiating position ought to be at the UNCED conference on global climate change. The Committee accepts that Canada must share in the responsibilities which must be shouldered if the global environmental challenge is to be met successfully. In this regard, the challenges and opportunities facing Canadian energy and mineral industries are particularly significant.

CHAPTER 2

THE CANADIAN ENERGY AND MINING SECTORS

CANADA'S ENERGY AND MINERAL OPTIONS

Fortunately, Canada is blessed with a wide array of energy sources. Options range from an abundant stock of traditional energy sources (e.g., oil, natural gas, coal, hydro, nuclear) to certain renewable forms of energy that may play a more significant role in years to come, to untapped energy efficiency and conservation potential. The Committee, cognizant of the wide variety of energy options available, decided at an early stage in its deliberations to organize its hearings on the basis of energy type. As was noted above, it was never our intention to choose amongst the various energy choices, but rather to comment on their current role in the Canadian economy and to examine environmental challenges associated with their development and use.

Figure 2.1 displays the mix of primary energy sources on which Canada relies. The current critical importance of the oil and gas industries is shown, with products derived from these two sources accounting for 70% of primary energy production. As was pointed out to us by the Canadian Petroleum Association, the upstream oil and gas industry contributes greatly to the Canadian economy, providing approximately $20 billion annually to domestic GDP. The sector also employs 85,000 (directly and indirectly) and generates over $5 billion annually for governments in taxes and royalties.[1]

Despite the generally diverse Canadian energy sector, oil remains a strategic commodity for certain end uses (e.g., transportation) and in certain regions (Quebec, Atlantic Canada) where alternative supply options are more limited. Although its share of total production has dropped recently, reflecting declines in conventional light oil production, oil still accounts for over one-third of our total energy production. Although Canada is now, and has been for some time, a net importer of conventional crude oil, exports of heavy and synthetic crude oil are such that Canada remains a net exporter of crude oil (and petroleum products). Exports of Western Canadian crude still offset imports into Quebec and Atlantic Canada.

Natural gas is a significant component of the energy mix. Indeed, this option is becoming more appealing because of its low price, long-term availability and environmental benefits. Prices in recent years dropped to 15-year lows, making fuel switching increasingly attractive to consumers. Moreover, whereas the reserves of conventional light oil are declining, reserves of natural gas show no such trend. Established Canadian gas reserves remain more than twice as large, on an oil-equivalent basis, as those of crude oil.

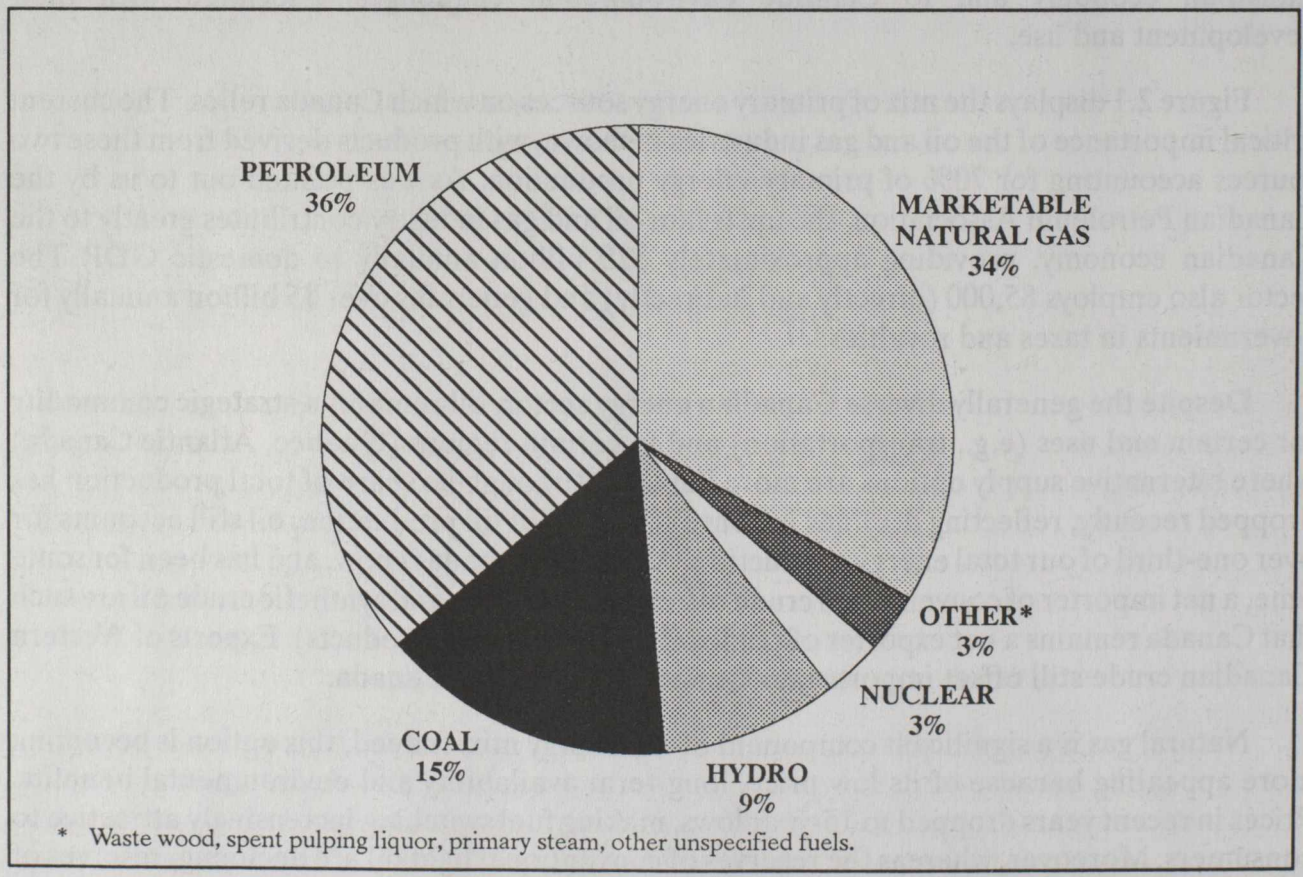
The Canadian gas industry relies extensively on the U.S. market. The total annual production of natural gas is currently in the order of 109 billion cubic metres with approximately 44% of this shipped south. Canadian exports of gas make up almost 9% of U.S. supply.

The electric power industry also displays a significant presence within the Canadian economy. Employment in the industry makes up slightly over 1% of domestic employment, and the industry's contribution to Canada's GDP has steadily risen over the years, from 2.3% in 1960 to 3.3% in 1991.(2)

Canada is an electricity-intensive country as well as a leading exporter of electricity, both in direct form and as an input to many of our export commodities. Electricity prices in this country have traditionally been amongst the lowest in the world, providing Canada with a comparative advantage when producing energy-intensive products. Resource processing and manufacturing industries have reaped particular rewards from low-cost reliable electricity. Electricity in Canada is produced in a number of different ways, most notably hydro, nuclear and coal-powered generation.

FIGURE 2.1

Primary Energy Production by Type 1991



* Waste wood, spent pulping liquor, primary steam, other unspecified fuels.

Source: Energy, Mines and Resources Canada and Statistics Canada, *Energy Statistics Handbook.*

Hydro-electric power continues to be the major source of electricity generation, with 62% of the country's electric power needs met from this source in 1991. Several provinces, most notably Quebec, British Columbia, Newfoundland and Manitoba, rely extensively on this form of power production.

Nuclear-electricity production, on the other hand, is concentrated in Ontario, so that while it provides for approximately one-half of that province's requirements, only 16% of national power needs are met this way. Moreover, the future of nuclear power in Ontario is, at the moment, extremely uncertain. The provincial utility, Ontario Hydro, has placed a moratorium on the construction of new facilities, to be in effect until the year 2009.

The Canadian Nuclear Association presented its case for nuclear energy on several fronts.(3) Apart from the proclaimed environmental advantages of this option, which are described elsewhere, the Association based its claim on the investment already made in the nuclear industry since 1974 (over $3 billion in federal R&D expenditures, at least $2 billion in assistance for reactors and heavy water plants, and $30 billion investment by utilities in CANDU generating plants), and its economic benefits. Among those identified, the following bear mentioning: total direct and indirect employment of 100,000; the development of a domestic high-technology industry; the creation of the world's leading uranium mining industry, accounting for approximately $1 billion per year in foreign exchange; and the development of peaceful uses of nuclear technology in non-energy fields.

As was noted in the submission of the Canadian Coal Association, the development of the Canadian coal resource is also regionally quite significant, in that coal remains the major source of electricity generation in Alberta (93%) and Saskatchewan (73%). Nova Scotia, at 61%, and Ontario (25%) are also major users of coal in generating power.(4) Overall, 16% of Canadian electrical generation is derived from coal.

Canada has large reserves of low-cost thermal and metallurgical coal; together, these account for approximately 70% of domestic hydrocarbon reserves. Apart from its use in generating power, coal also creates demand for inputs such as steel through purchases of mining equipment while coal transportation also generates employment. Furthermore, much of Canada's output of metallurgical coal is exported and produces important foreign exchange revenues.

Coal is viewed as an important energy source for developing countries. The Canadian industry is attempting to position itself to satisfy this market, while at the same time developing clean coal technologies to reduce harmful environmental impacts. Coal mining activity accounts for roughly 10% of total employment in the Canadian mineral sector, and directly and indirectly contributes $3.2 billion to total domestic income.(5)

The current share of primary energy demand supplied by renewable energy sources, remains quite low at just 5-7%. Energy derived from direct combustion of biomass (primarily wood, agricultural wastes and municipal wastes) makes up the largest share. A major part of the pulp and paper industry's energy needs are met through the burning of wood and pulping wastes. Southern Canada is also well endowed with substantial mineable peatlands, although these are not currently used as a fuel source to any extent.

There is no doubt that sources of renewable energy will continue to contribute to Canada's energy supply and should contribute an ever-growing proportion of overall supply. Growing environmental pressures and changes to governments' current policies may enhance their ability to compete with conventional energy sources. On the negative side, low world oil prices will continue to dampen the incentive to develop alternative energy sources, if all other pertinent factors remain unchanged.

Solar and wind technologies, while they have exciting potential, are at this point minor contributors in satisfying our domestic energy requirements. Their share could rise given some helpful combination of lower production costs, altered public policy and internalization of environmental costs in the pricing of all energy commodities. While there is some reason for optimism, particularly for wind energy technology, and while governments may choose to alter their fiscal and taxation policies virtually at will, the prospects for a full internalization of environmental costs for competing energy sources can be best described as unlikely in the short run.

Hydrogen has often been touted as the clean energy source of the future, but much R&D work needs to be undertaken if its potential is to be realized. It is not viewed by its proponents as a readily available substitute energy form, but rather as an essential key in Canada's industrial future. At present, only 30% of Canadian hydrogen production is directly or indirectly related to the energy sector. In the future, hydrogen's role in the energy sector will largely depend on the pace of oilsands development and the emergence of new hydrogen end-use technologies.

Improvements in energy efficiency and increased energy conservation are being increasingly viewed as an attractive source of energy services as in, for example, the designation of electrical power saved through heightened efficiencies as "negawatts."(6) Many energy consumers are less interested in what primary energy source produced a particular unit of energy than they are in the value that this energy provides (for example, heat for the home, or fuel for the automobile).

Increasingly in Canada, electrical and gas utilities are placing more attention on demand-side management (DSM) programs designed to curb existing consumer demand for energy to secure as many available "negawatts" as possible. It is generally recognized that investments in DSM activities are often the cheapest way to satisfy energy requirements, and reduce the need to build large-scale and costly new facilities. Yet substantial barriers remain to a more successful realization of the conservation potential.

Finally, the Canadian minerals sector is a major contributor to domestic economic growth, to the economy generally, and to local communities throughout Canada. The value of Canadian mineral production, including metallic minerals, non-metallic minerals and structural materials totalled just under $15 billion in 1990. Of this, metals' share was 70%.(7)

Canada is a leading world producer of many metals, such as copper, nickel, zinc concentrates, lead, gold and silver, and derives significant revenues from the export of such commodities. A breakdown of our mineral production for the years 1990 and 1991 is presented in Table 2.1.

TABLE 2.1
Canada, Production of Leading Minerals, 1990 and 1991

Minerals	(000 Tonnes except where noted) 1990	1991[P]	YRLY % CHG.	($ millions) 1990	1991[P]	YRLY % CHG.
METALS						
Gold (kg)	167,372.5	176,720.1	5.6	2,407.7	2,355.3	−2.2
Copper	771.4	773.6	0.3	2,428.9	2,101.2	−13.5
Nickel	195.0	189.2	−3.0	2,027.9	1,828.2	−9.8
Zinc	1,179.4	1,079.9	−8.4	2,272.6	1,351.0	−40.6
Iron Ore	35,670.0	35,961.1	0.8	1,258.8	1,307.9	3.9
Uranium (tu)	9,720.2	7,813.3	−19.6	888.0	472.1	−46.8
Lead	233.4	239.6	2.7	279.3	203.9	−27.0
Silver (t)	1,381.3	1,239.9	−10.2	249.7	185.3	−25.8
Platinum GRP (kg)	11,123.4	10,955.4	−1.5	189.4	141.8	−25.1
Molybdenum (t)	12,188.5	11,292.0	−7.4	84.7	70.4	−16.9
NON METALS						
Potash (k_2O)	7,344.6	7,012.0	−4.5	964.9	919.0	−4.8
Asbestos	685.6	670.4	−2.2	272.1	274.5	0.9
Salt	11,191.4	11,585.3	3.5	240.9	258.6	7.3
Sulphur (elemental)	5,822.1	6,029.0	3.6	368.9	244.1	−33.8
Peat	774.6	737.1	−4.8	89.7	91.7	2.2
Sulphur (in smelter gas)	789.8	726.4	−8.0	81.2	76.6	−5.7
STRUCTURALS						
Cement	11,745.2	9,395.9	−20.0	991.4	816.8	−17.6
Sand & Gravel	244,315.8	200,497.1	−17.9	817.3	631.4	−22.7
Stone	111,351.8	85,784.8	−23.0	662.9	512.8	−22.6
Lime	2,340.7	2,335.8	−0.2	188.3	186.3	−1.1
Clay products	..	..	..	136.0	139.4	2.5

.. Not available
P Preliminary

Source : Energy, Mines and Resources Canada, 1991 *Canadian Minerals Yearbook.*

THE OVERALL ECONOMIC SIGNIFICANCE OF THE ENERGY AND MINERAL SECTORS

The energy and mineral sectors contribute substantially to the vitality of the Canadian economy. Historically, our abundance of cheap, available energy resources has assisted us in developing a strong industrial economy and given us a competitive advantage over many other industrialized nations. Many of the products we sell abroad are energy-intensive.

Over the years, the principal concern of energy policy-makers has been to maintain secure supplies of competitively priced energy in order to fuel the economy and ensure the continuation of our standard of living. The energy sector thus was, and continues to be, an important contributor to the performance of other sectors of the economy. Many other industrial activities, most notably pulp and paper, non-metallic mineral products (e.g., lime, cement), chemical products and the smelting and refining of primary metals, depend critically on the input of energy.

At the same time, the energy sector provides the domestic economy with important direct benefits, which are observed in the areas of GDP, employment, investment, tax revenues at all levels, and exports. As Figure 2.2 illustrates, energy industries contributed over $33 billion to the Canadian economy in 1991, which in percentage terms amounted to approximately 6% of that year's GDP.

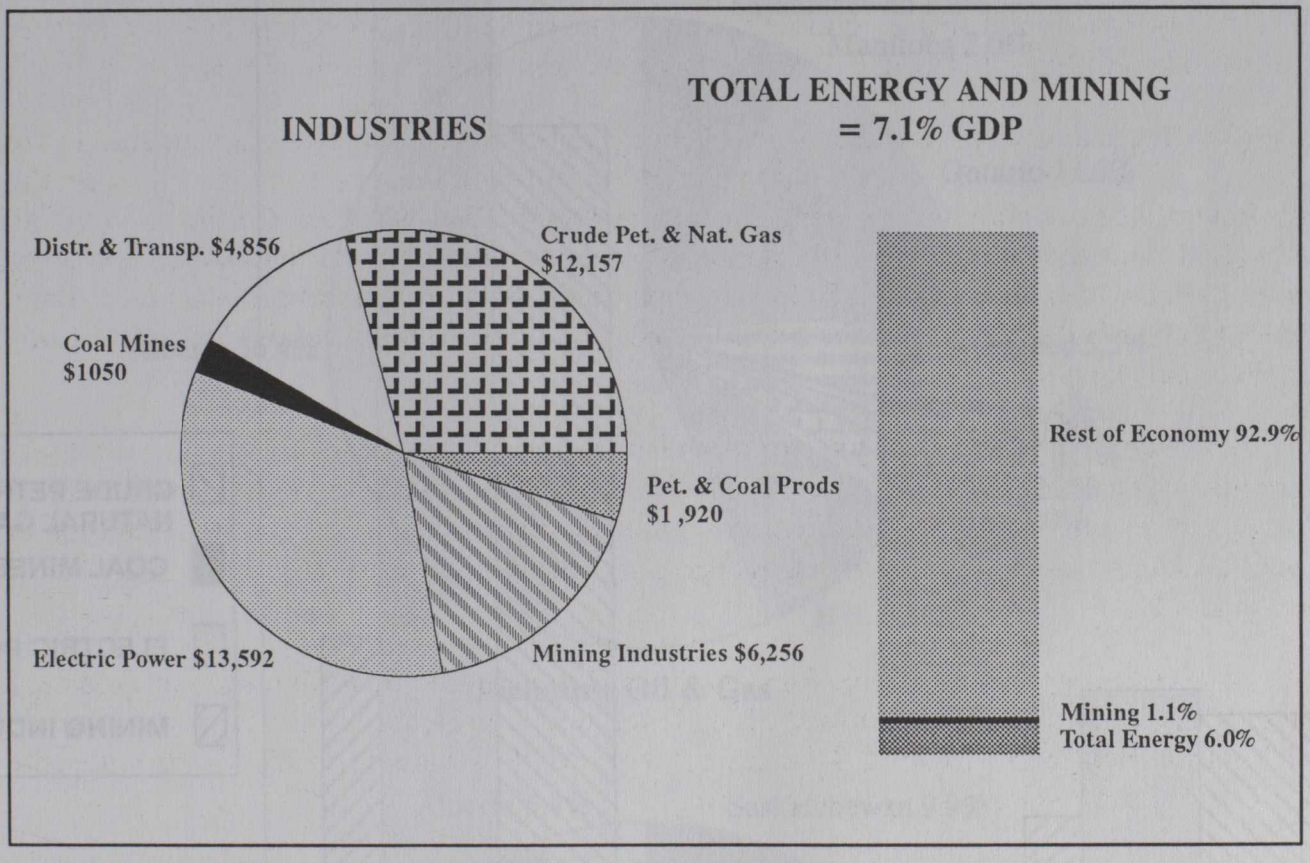
Apart from generating income for Canadians, the energy sector accounts for an important share of the country's employment activity and investment flows, accounting for approximately 19% of total investment. Figure 2.3 illustrates that the bulk of this contribution is accounted for by oil and gas, and electric power generation.

The energy and mineral sectors are also important sources of export revenues and are a principal factor in Canada's positive trade balance. Next to automobiles, energy represents the largest export commodity, registering a trade surplus of approximately $9.4 billion in 1991. Virtually all our energy exports are made up of fossil fuels, with most of these sent to U.S. markets.

There is no question that the Canadian energy sector relies heavily on the export market. In 1990, a full 44% of energy output was sent abroad. The fact that we are so trade-dependent has tremendous significance in terms of the requirement to keep costs down and remain competitive. Operating as it does in an increasingly competitive global economy, and with an economy which is open and yet small, the Canadian energy sector must be constantly vigilant in its efforts to compete with other countries around the world.

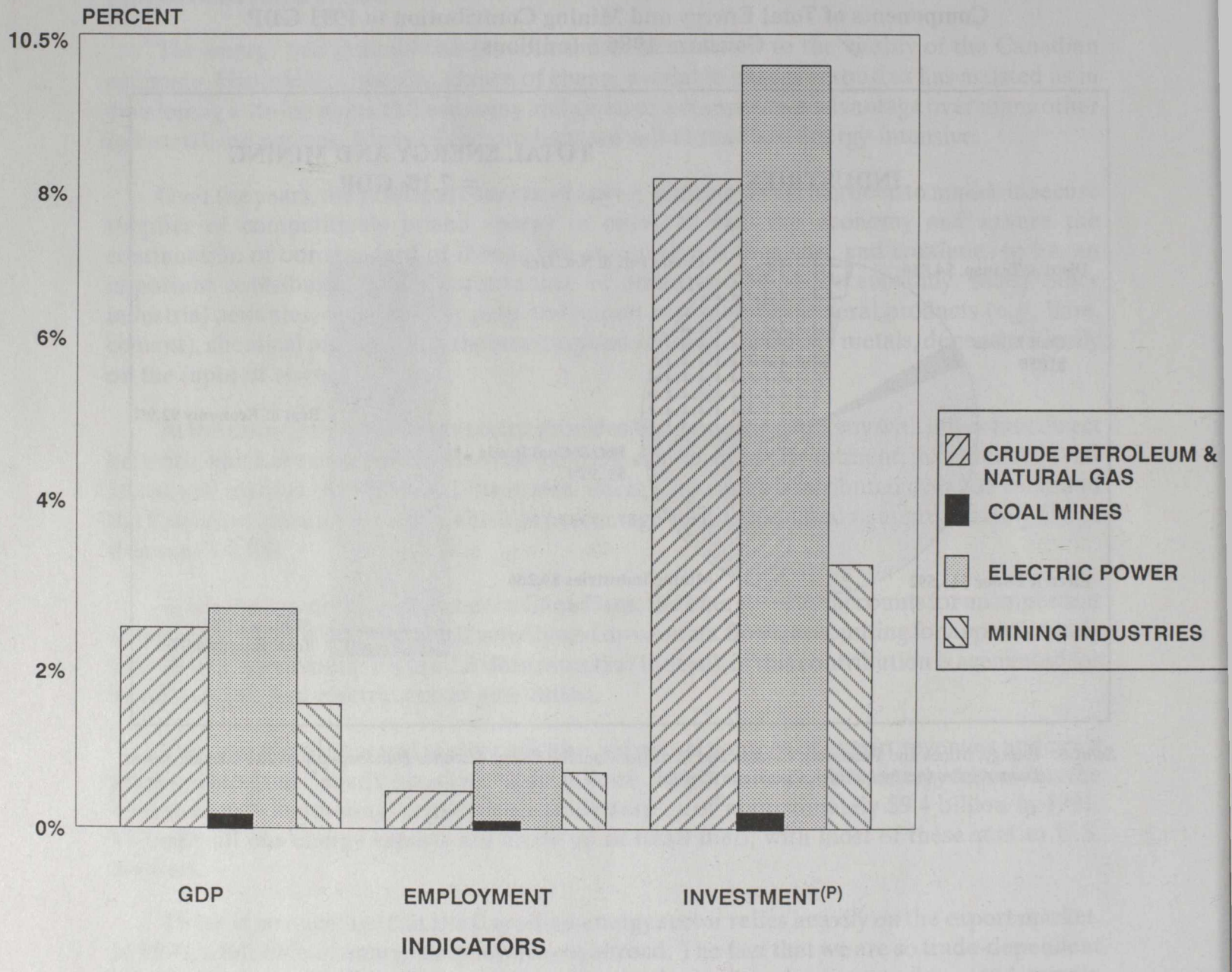
FIGURE 2.2

Components of Total Energy and Mining Contribution to 1991 GDP
Constant 1986 $ (millions)



Sources: Energy, Mines and Resources Canada and Statistics Canada, *Energy Statistics Handbook*; Statistics Canada, *Gross Domestic Product by Industry*, Catalogue 15–001

FIGURE 2.3
Energy and Mining Share of the Economy 1991



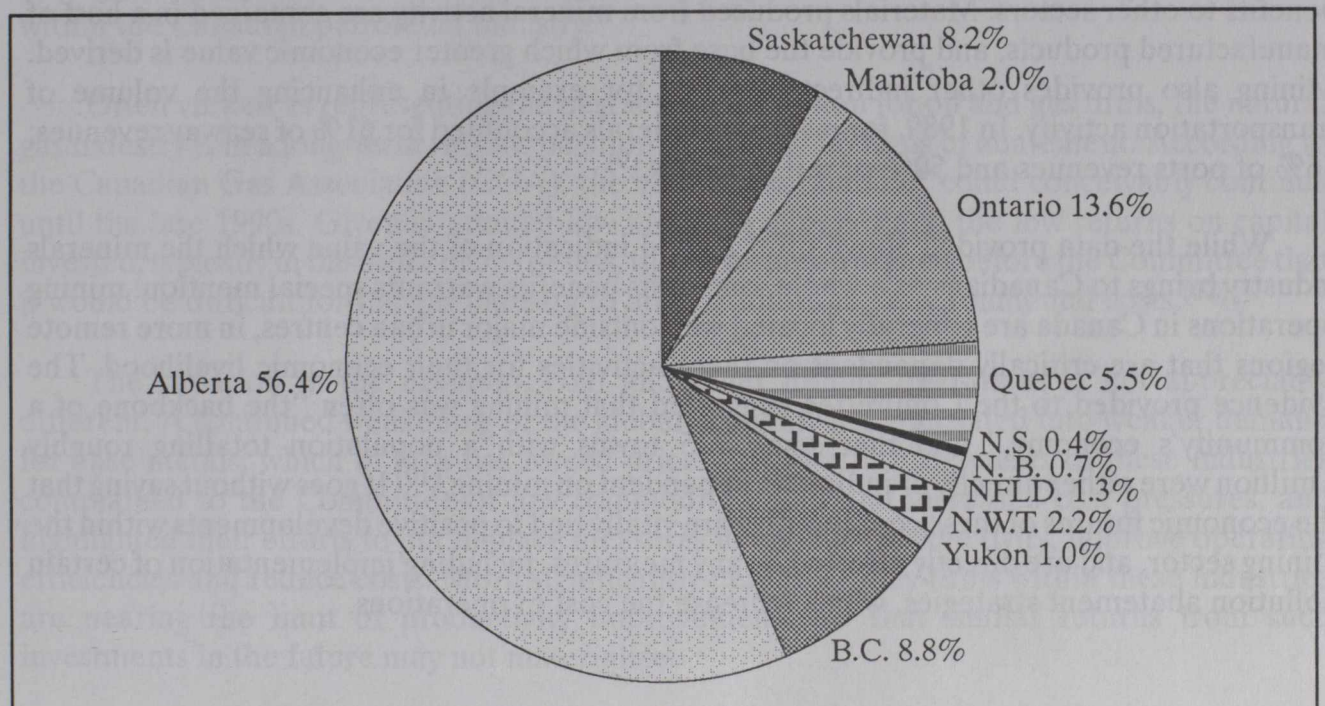
(P) Preliminary Data

Source: Energy, Mines and Resources Canada and Statistics Canada, *Energy Statistics Handbook*; Energy, Mines and Resources Canada 1991 *Canadian Minerals Yearbook.*

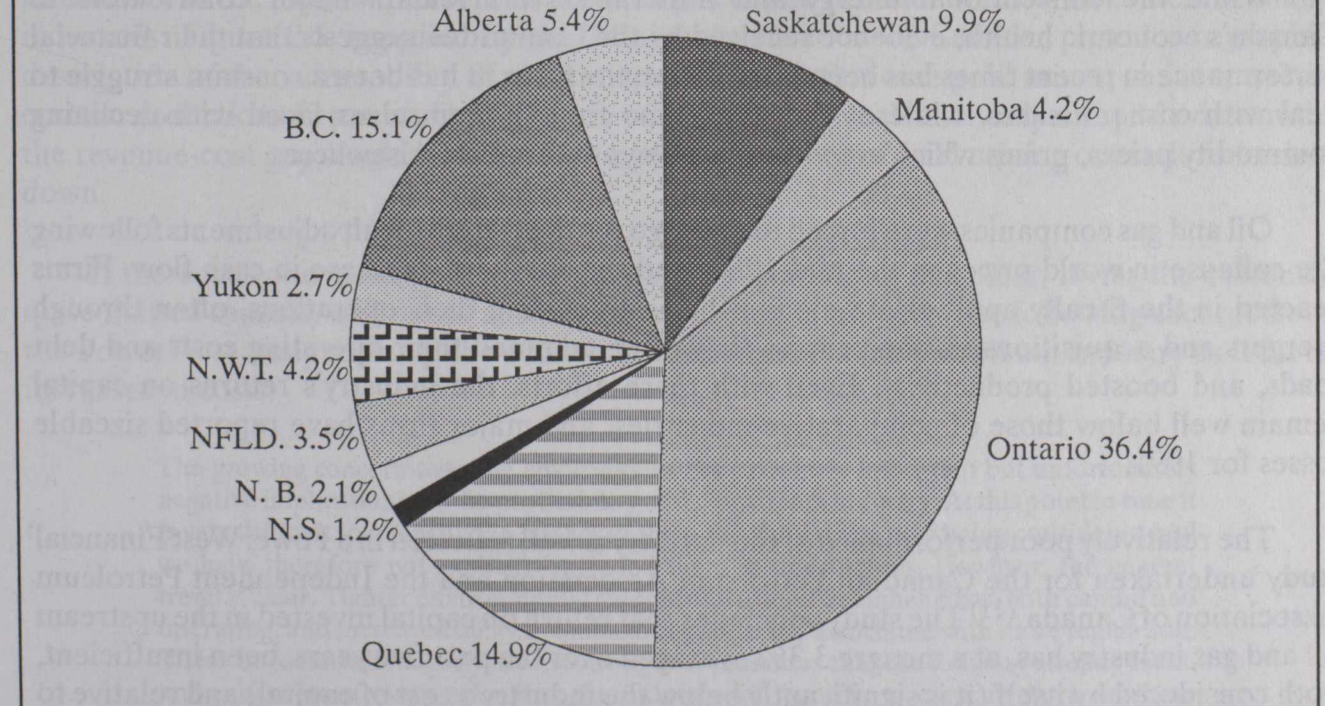
Distinct regional differences are found in energy production and consumption (see Figure 2.4). As is generally well known, the production of hydrocarbons (oil, natural gas, coal) is highly concentrated in one region, the Western Canadian Sedimentary Basin. It is therefore not surprising that energy activities provide one-fifth of the economic production (GDP) within the Prairie region of Canada.

FIGURE 2.4

Regional Share of Total Energy and Mining Industry GDP 1990 (P)



Including Oil & Gas



(P) Preliminary data

Excluding Oil & Gas

Source: Statistics Canada, Catalogue #15–203 (Unpublished data).

The mining sector, too, contributes greatly to our domestic wealth and to our standard of living. According to information provided by EMR, the minerals industry, including semi-fabricating and fabricating operations, accounted for 4.5% of Canadian GDP in 1990, for a total contribution of $26.9 billion.(8) The minerals sector also provides substantial economic benefits to other sectors. Materials produced from mineral activity are contained in a host of manufactured products, and provide the base from which greater economic value is derived. Mining also provides other indirect benefits, for example in enhancing the volume of transportation activity. In 1989, for instance, minerals accounted for 61% of seaway revenues; 56% of ports revenues and 50% of rail revenues.(9)

While the data provided above offer a good indication of the value which the minerals industry brings to Canadians as a whole, one of its benefits warrants special mention: mining operations in Canada are generally located well outside major urban centres, in more remote regions that are critically dependent on these activities for their economic livelihood. The evidence provided to the Committee suggested that mining was often "the backbone of a community's economy," and that some 115 towns with a population totalling roughly 1 million were either directly or indirectly dependent on mining.(10) It goes without saying that the economic futures of these communities are vitally tied to positive developments within the mining sector, and are directly affected by any measures, including implementation of certain pollution abatement strategies, which increase the cost of operations.

RECENT FINANCIAL PERFORMANCE

While the conventional energy and mineral sectors remain major contributors to Canada's economic health, evidence received by the Committee suggests that their financial performance in recent times has been poor. For many firms, it has been a constant struggle to deal with cost pressures, while at the same time finding themselves faced with declining commodity prices, prices which are virtually always determined elsewhere.

Oil and gas companies were forced to undergo particularly difficult adjustments following the collapse in world prices in the mid-1980s and the resultant decrease in cash flow. Firms reacted in the fiscally appropriate manner by restructuring their operations, often through mergers and acquisitions; in the process they often trimmed their operating costs and debt loads, and boosted productivity. Even with these efforts, the industry's returns on capital remain well below those of comparative industries, and major firms have reported sizeable losses for 1991.

The relatively poor performance of the industry is well reflected in a PowerWest Financial study undertaken for the Canadian Petroleum Association and the Independent Petroleum Association of Canada.(11) The study concludes that return on capital invested in the upstream oil and gas industry has, at a meagre 3.3% averaged over the past five years, been insufficient, both considered by itself (it is significantly below the industry's cost of capital) and relative to the returns achieved by other economic activities (8% annual average since 1986). The deterioration in profitability has been particularly severe since 1985. Regrettably, the study also predicts that current market conditions will persist through the first half of the 1990s.

The oil sector has undoubtedly been significantly affected by developments in recent years. In addition, Canada is faced with an accelerating decline in conventional crude oil production, particularly in light crude oil balances, through the 1990s. These developments are largely responsible for the restructuring and widespread contraction currently taking place within the Canadian petroleum industry.

Often viewed as representing the best long-term option for oil and gas firms, the natural gas industry is in a long-term surplus position that shows no signs of abatement. According to the Canadian Gas Association (CGA), the natural gas "bubble" could conceivably continue until the late 1990s. Given continued low natural gas prices and the low returns on capital invested, typically in the order of 5% or less, the Association argued before the Committee that it would be difficult for the gas industry to absorb additional environmental costs.(12)

The situation in the uranium, coal and other mining operations is not appreciably different. A continued weakening of the global economy has translated into weaker demand for base metals, which in turn has forced prices downward. Proponents of these industries complained to the Committee of low commodity prices and increased cost pressures, and highlighted their efforts to put in place measures to enhance productivity, improve operating efficiencies and reduce costs. More significantly perhaps, many firms within these industries are nearing the limit of productivity improvements, so that similar returns from such investments in the future may not materialize.

Although many common threads ran through the various submissions from the conventional energy and mineral producers, one that particularly seized the Committee's attention was the narrow differential between prices and production costs so evident in many industries. Figure 2.5, supplied by the Mining Association of Canada, provides a graphic description of the vulnerability of certain operations, in this case gold mines, to increases in costs or reductions in prices. Examination of this graph reveals that only minor deviations in the revenue-cost gap would be required to cause a number of gold mining operations to shut down.

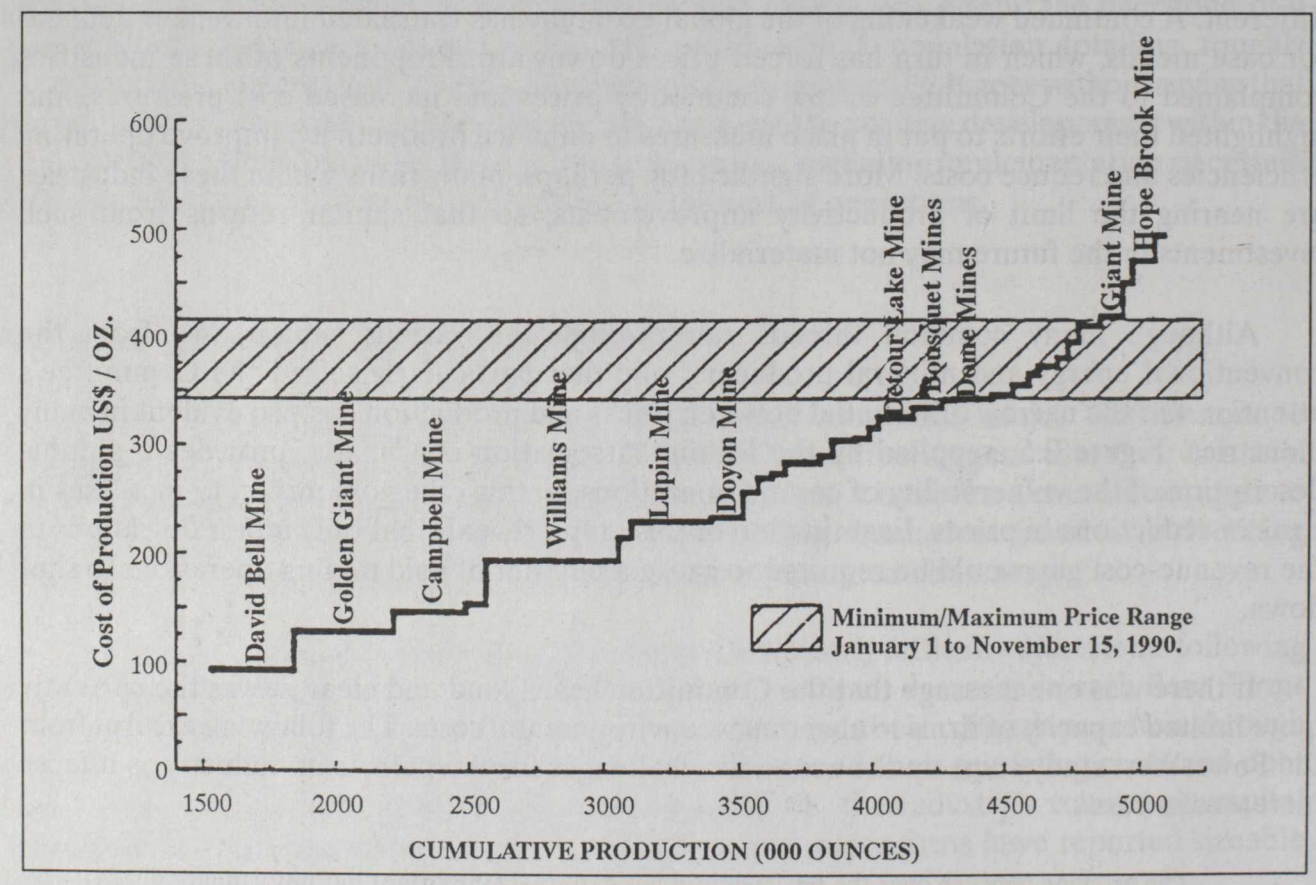
If there was one message that the Committee heard loud and clear, it was the currently quite limited capacity of firms to absorb new environmental costs. The following excerpt from the PowerWest study sums up the economic challenges for the petroleum industry as it faces increases in costs:

> The growing concern over the environment has extremely important but unfortunately negative implications for the profitability of the upstream industry. At this point in time it is very difficult to quantify the impact of the policy initiatives now being considered and we have therefore not explicitly included them in our analysis. However, the general trend is clear. Tighter environmental standards will lead to higher costs, both capital and operating, and increased delays, complexities and costs associated with more regulation. These burdens will magnify the mounting cost pressures that the industry already faces, and prospects are very poor that the industry will be able to earn a return on these expenditures. Canadian oil and gas producers are price takers for both oil and gas and the higher costs of complying with stricter environmental standards will be very difficult to pass through to consumers unless they are equally borne by U.S. and international competitors.(13)

This is a rather stark and compelling assessment, and leaves domestic policy-makers with a challenging assignment to assist the industry in its efforts to make environmental gains. Given the current resource pricing difficulties facing the industry as well as the dismal profit picture which the evidence we heard and the PowerWest study paints, there can be no doubt that it will be largely up to governments to put the policy measures in place which will generate or free up the capital necessary for investment in new, less environmentally harmful technology and processes. While a number of options are available, none is without cost. Yet, if the environmental challenges are to be met, and we believe they should be met, these costs will have to be borne.

FIGURE 2.5

Major Canadian Gold Mines Cash Production Costs 1989



Source : Mining Association of Canada.

One alternative which can be rejected almost immediately is a generalized relaxation of environmental standards. Not only would this be damaging from an environmental point of view, it was clear from the evidence provided to the Committee that witnesses did not favour this approach. Rather, an urgent message went out to the Committee that governments need to "regulate smarter" and, in certain instances, move beyond regulation towards the potentially more cost-effective use of additional policy instruments. As is further developed in Chapter 16, there is benefit in governments identifying clearly sequenced priorities in environmental

policy and in developing a set of policy measures which will elicit the most effective reaction from industry. Often, this will mean a move towards the greater use of environmental performance standards, leaving the "how to" to business. In other cases, the use of economic instruments such as tradeable emissions permits, taxes and pollution charges may hold significant advantages over the rigid "command and control" types of regulations which have historically dominated. Whatever instrument is used, it can only be truly effective if it can generate the desired results without imposing ruinous costs on industry.

Improvements in the application of environmental policy will certainly assist in producing more effective use of the capital which the industry has at its disposal to invest in the effort to meet environmental challenges. However, if real progress on the environment is to be made, the tremendous requirements for capital in this area will need to be satisfied through the implementation of more substantive measures.

One alternative which some maintain could deal with the depressed conditions felt in the market place is price reregulation. This is one option the oil and gas industry in particular, given its experiences with the National Energy Program (NEP), has consistently rejected. Apart from the potential trade implications of a policy-induced change in resource pricing, efforts to regulate price also presuppose the ability of governments to predict future prices. As the experience with NEP clearly indicated, government intervention in the form of price-setting introduced sizeable distortions in the market place and caused economic pain to the province of Alberta. We cannot support this option.

Another option which may, at first glance, be more palatable, is to lower the value of the Canadian dollar *vis-à-vis* that of our southern trading partner. The authors of the 1991 PowerWest study estimated that the upstream oil and gas industry had to forego a total of $3.5 billion in lost revenue as a result of the appreciation of our dollar since 1985. Other natural resource industries including mining were also adversely affected in this time period.

Undoubtedly, industries which are net exporters benefit from a lowering of the value of the domestic currency. However, changes in exchange rate policy are inexorably interwoven with modifications in monetary policy. Alteration of government policy in this area may have tremendous implications for interest rates, for inflation, for the health of other sectors of the economy and, more generally, for the country's economic performance as a whole.

To inject capital into this moribund sector of the economy so that industry can effect increasingly stringent environmental standards, the provision of direct assistance in the form of tax and royalty relief is a viable option. Again, reference to the oil and gas industry is most useful, given its use by governments over the years as a pliable source of revenues. The industry continues to be viewed by governments as a cash cow, a convenient source of revenues for their many spending initiatives. In 1990, for example, the industry returned to governments a full $10.3 billion in various forms of royalties, sales, excise and income taxes. At a time when registered rates of return on capital have been extremely low, changes in government taxation policy could help return profitability performance to more traditional levels, at the same time helping to encourage exploration and development. It may therefore be time for governments to view the industry in a different light, thereby helping to level the playing field in the energy sector.

Singled out in particular as a primary contributing factor behind the poor profitability of the upstream oil and gas industry is the royalty burden which provincial governments have historically placed on the industry. While the total royalty take has fallen in recent years, the sizeable withdrawal of funds from the industry which has occurred ($3.3 billion annually on average since 1986) has induced considerable pain on an industry which is not profitable.

Indeed, the entire notion of the requirement on the part of provincial governments to extract economic rent in the form of a royalty on industry revenues and not profits, is being questioned. The PowerWest study places this re-examination of the royalty concept aptly into context:

> It is hard to see how the concept of "economic rent" can apply to an industry that has been unprofitable for many years, and when there is little basis to expect a restoration of reasonable profitability into the foreseeable future. The royalty structure today does not fit the circumstances of an unprofitable industry. Nor does it reflect the realities of today's investment economics which are very marginal under current consensus price forecasts.(14)

Regardless of which policy option is selected, there will be a need in the setting of environmental policy to tie the assistance which is provided to environmental effort on the part of industry. Firms must be made to realize that the *quid pro quo* of fiscal relief, or capital infusions generated by other means, must be tougher environmental standards and committed action on the environmental front. Without this vital link, the financial aid which is provided will be viewed poorly by Canadians.

THE NEED TO MAINTAIN INTERNATIONAL COMPETITIVENESS

In our increasingly global economy, the question of international competitiveness is of paramount importance, nowhere more so than in energy and mining. In most energy and mineral markets, Canada's share of total world production is quite modest. We therefore have little influence over price, and must accept the price determined in world markets. Except to the degree that the value of the Canadian dollar may influence the fiscal manoeuvring room of companies in the industry, the prevailing world price effectively imposes a ceiling on the costs that can be incurred in the production of goods and services for export. Given that firms have virtually no freedom to adjust their prices to reflect internal changes in costs, they must be constantly vigilant regarding their financial position. Firms that cannot remain cost-competitive will not be able to survive.

It must be in this light that environmental and other costs are viewed. In these increasingly difficult and competitive times, the margin between costs and revenues (the latter being largely beyond our control) is often quite narrow. Unilateral domestic action that reduces or eliminates this margin, in the absence of compensating or counterbalancing actions,will be harmful to the interests of Canadian industries, which are heavily dependent upon energy. Canada's energy intensity and the share of output that is exported are both high. These are important factors to consider when deciding on an appropriate level of environmental response.

ENDNOTES

(1) Canadian Petroleum Association, "The Canadian Petroleum Association's Response to Current and Future Environmental Challenges," Brief Presented to the House of Commons Standing Committee on Energy, Mines and Resources, Ottawa 1991, p. 5.

(2) Energy, Mines and Resources Canada, Electricity Branch, *Electric Power in Canada 1991*, 1992, p. 2-3.

(3) Canadian Nuclear Association, Brief Presented to the House of Commons Standing Committee on Energy, Mines and Resources, Ottawa 1991, p. 8.

(4) Canadian Coal Association, "Canadian Environmental Challenges: A Perspective by the Coal Association of Canada," Brief Presented to the House of Commons Standing Committee on Energy, Mines and Resources, Ottawa 1991.

(5) Morgan MacRae, Presentation to the House of Commons Standing Committee on Energy, Mines and Resources, Ottawa 1991, p. 2.

(6) As in Amory B. Lovins, "Energy, People, and Industrialization," Paper commissioned for the Hoover Institution Conference "Human Demography and Natural Resources," The Hoover Institution, Stanford, California, 1-3 February 1989.

(7) Energy, Mines and Resources Canada, *1991 Canadian Minerals Yearbook*, 1992, p. 1.5.

(8) Ron R. Sully, "Minerals and the Environment," Notes for a presentation to the House of Commons Standing Committee on Energy, Mines and Resources, 2 October 1991, p. 3.

(9) *Ibid.*, p. 3.

(10) Mining Association of Canada, "Environmental Challenges to the Mining Industry," Brief Presented to the House of Commons Standing Committee on Energy, Mines and Resources, Ottawa 1991, p. 2.

(11) PowerWest Financial Ltd., *Canadian Upstream Oil & Gas Industry Profitability: Historical Review and Future Perspectives*, Executive Summary, September 1991.

(12) Canadian Gas Association, Response to the Committee's Consultants' Comments, p. 5.

(13) PowerWest Financial Ltd. (1991), p. xii.

(14) *Ibid.*, p. 59.

CHAPTER 3

THE ENVIRONMENTAL CHALLENGES

AN OVERVIEW OF THE ENVIRONMENTAL DEMANDS FACED BY THE ENERGY AND MINERAL INDUSTRIES

The Department of Energy, Mines and Resources, in an August 1990 discussion paper, noted that the environment would, in all probability, be "the single most important issue confronting the energy sector in Canada and around the world over the next several years."(1) Of this, there can be no question. While certain other issues, such as the battle over natural gas pricing with the California Public Utilities Commission and the diminishing supplies of conventional light crude, have recently come to the forefront of the energy policy-making agenda, the environment has been the one concern that has consistently held the attention of the Canadian energy sector and the Canadian people.

There is no question that the energy and mineral sectors are closely tied to the dominant environmental concerns of today. Increasing demands for action, originating with environmental groups, other levels of government, international protocols and consumers have forced domestic policy-makers into finding solutions to environmental issues in a relatively short period of time.

This chapter provides a thumbnail sketch of the environmental effects of energy and mineral activity throughout the production cycle. It also provides an introduction to the major environmental challenges which these two sectors face. More specific sectoral information, including the steps which industry has historically taken to lessen environmental damage, is left to Chapters 5 through 15.

As we have noted, Canada relies on a wide mix of energy sources for its domestic needs. We have no doubts that this will continue to be the case in the near term. It also holds that no energy type is entirely benign in its environmental impacts, and that a variety of environmental effects can be observed at all phases in the resource cycle, from extraction and transformation to delivery and end-use.(2)

Through careful planning, energy and mining firms have, over the years, ensured that the environmental effects associated with the exploration stage are limited. Exploration decisions have traditionally been based on the environmental sensitivity of a given area. As a result, the disruption of existing land use patterns has, for the most part, been kept to a minimum.

At the extraction or production stage, oil and gas well drilling introduces the potential for blowouts and pipeline breakage. Hydroelectric developments, which have already been identified as contributing over 60% of our electric power, alter water volumes in river systems and sometimes require the formation of large reservoirs. Both of these effects transform the

existing ecosystems. The mining of coal, uranium, oilsands and other deposits can result in sizeable changes in existing lands and disrupt traditional land use patterns. Land reclamation efforts need to be undertaken to restore disturbed land to a condition approaching its original state. Moreover, rivers and lakes can become contaminated with both solid and liquid wastes, if remedial steps are not taken to contain them. Although the problem of acid mine drainage from rock dumps and tailings ponds may be less well known to the general public than other environmental challenges, it is generally recognized by the mining sector and by governments as being the foremost environmental issue within that sector.

Environmental impacts can also materialize from transporting energy and mineral products. The Canadian public is fully aware of spills from crude oil supertankers, such as the one that occurred near Valdez, Alaska. Many citizens are also cognizant of the health concerns that have been expressed about the electro-magnetic fields in the vicinity of electric power lines. Perhaps less well known, because of its infrequency, is the risk of an accidental rupture of an oil or natural gas pipeline. There are also considerable risks associated with the transportation of liquefied natural gas. Because pipelines and transmission lines require rights-of-way, they have a land use impact.

While the above environmental effects are not insignificant, by far the greatest are observed in the processing and end-use phases of the resource cycle. Transforming primary energy and mineral resources into useful products for consumers and other industries generates contaminants in the air, water and soils. Natural gas processing facilities, oilsands plants, petroleum refineries and mining smelters are examples that come quickly to mind. At the ultimate, end-use level, the burning of non-renewable fossil fuels to provide secondary energy services such as heat, power and transportation energy, along with certain transformation processes, result in the release of combustion gases, excess thermal discharge and direct solid and liquid wastes. Of most concern to the public and policy-makers at present are the gaseous emissions of oxides of carbon, nitrogen and sulphur that result from energy and mineral processing and from energy use. While fugitive, or unintended, emissions are produced at the various stages of fuel processing, handling and transportation, these are dwarfed by emissions released at the point of combustion.

Waste disposal represents a sizeable challenge for the nuclear sector, which thus cannot be considered as without environmental concerns even though its downstream non-thermal emissions are currently held by nuclear operators to be minimal. Apart from being concerned about the radiative effects of uranium production, storage and distribution, a considerable segment of the Canadian public continues to worry about the safe long-term disposal of irradiated fuel from nuclear power plants and reactor components, and the potential for nuclear mishaps.

While renewable energy sources such as biomass, hydrogen, and wind and solar power are generally recognized to be less polluting, they too exert their own unique environmental effects. The combustion of biomass, for instance, produces CO_2, volatile organic compounds (VOC) and particulate emissions, and generates solid waste. While hydrogen may be clean when burned, currently its most common form of production involves the steam reforming of methane, a process which does release greenhouse gases. Even solar energy and wind energy carry some environmental costs, principally at the manufacturing level. Nevertheless, these

are decidedly more local in nature, and considerably more limited in magnitude than those from other energy sources. These examples point out the critical need for a full fuel cycle analysis of environmental impacts.

MAJOR ENVIRONMENTAL CONCERNS

Although activity within the energy and mineral sectors can affect the environment at every phase of the resource cycle, much of the concern surrounding the link between natural resources and the environment is directed to atmospheric emissions, which contribute to the following three key issues: global climate change; acid rain; and ground level ozone (urban smog). Given the overwhelming dominance of these issues in terms of current environmental challenges, we are of the view that more discussion of them is warranted here. This is in no way meant, however, to minimize the importance of other concerns.

The issue of global climate change is substantially more complex than the other two. The theories associated with this environmental issue are less proven and cost-effective technologies for controlling greenhouse gas production are not yet apparent. Moreover, as its name suggests, the climate change issue is global in nature, whereas many of the other problems are more local or regional. Any movement towards a resolution of the perceived problem will require international as well as national action.

A. Global Climate Change

1. The "Problem" Defined

In its natural state, the earth's atmosphere contains a number of important gases, such as CO_2 and water vapour, which prevent reflected solar radiation from escaping into space. By acting as a "greenhouse," these gases regulate the temperature on our planet. Without the contribution of these greenhouse gases to the maintenance of adequate atmospheric temperatures, plant and animal life as we know it could not exist.

The concern that has developed over the greenhouse effect is twofold: (a) that human activity has increased the atmospheric concentration of a number of the gases (particularly carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs) and nitrous oxide (N_20)) and (b) that there may be a direct link between the rise in gaseous concentration and mean global temperature, and that such a rise in temperature if it occurs, would exert a number of deleterious climatic effects such as coastal flooding, inland drought and greater volatility in weather patterns.

While a general consensus has developed within the scientific community that a significant long-term warming trend is under way and that there is a direct link between anthropogenic (man-made) activity and climate change, total certainty does not exist on either count. A small, yet not insignificant number of climate experts dispute the existence of a measurable link between human activity (such as fossil fuel combustion) and the warming trend, and prefer to attribute the latter to short-term natural variations.

Even if one accepts the causal link, there is considerable uncertainty about the timing and magnitude of the temperature rise. Sophisticated computer-based attempts to model the global climate have provided various ranges of projected future temperatures. The majority of the primary models have predicted an increase in average global temperature unless the nature of human activity is altered. According to EMR's discussion paper on the subject, the models suggest that global mean temperatures could be 1.5-3 degrees Celsius above pre-industrial levels by 2030 and in a range of 2.5-6 degrees Celsius higher by the year 2090.(3) The latest studies undertaken by the International Panel on Climate Change forecast that the rise in temperature attributed to greenhouse gas emissions would lie at the lower level of these ranges.

It is anticipated that temperature increases of a relatively high magnitude would result in significant changes in global weather patterns, although the extent of this effect is extremely difficult to determine. The principal global models being used today predict such phenomena as coastal flooding, variations in patterns of rainfall and snowfall, and increased frequency of windstorms. Changes in weather patterns such as these would almost certainly harm global agricultural production.

This Committee does not claim to have the expertise to make a definitive assessment of these issues, nor was this question a focus of the hearings. Undoubtedly, the issue will require substantial additional scientific research. Given the serious potential implications of the greenhouse effect, we fully support present government involvement in this area. In our view, Canada should participate fully in the global effort to seek out the scientific truth on this issue.

2. Implications For The Canadian Energy Sector

There can be no doubt that the global climate change issue has tremendous implications for the domestic energy sector, and poses a significant challenge for the mining industry. As Figure 3.1 clearly illustrates, energy's contribution to greenhouse gas emissions is, at 69%, sizeable. While other sectors, such as agriculture, are also major contributors, their overall influence is considerably smaller. The domestic energy sector's most important contribution is felt through emissions of CO_2; in that it contributes 95% of all CO_2 emitted. Energy's contribution to the other gases mentioned, although not inconsequential, is not generally of the same order of magnitude; for CFCs it is not a factor at all.

CO_2 is by far the dominant greenhouse gas, accounting for 56% of the "global climate change potential" of different gases (see Figure 3.2). This potential effect, in turn, is based on the following factors: emissions, radiative potency and the duration of time in the atmosphere. Other gases, such as methane, may capture solar radiation more efficiently, but their atmospheric concentrations are not as great.

A breakdown of CO_2 emissions by fuel type, contained in Figure 3.3, reveals that a full two-thirds of emissions can be attributed to the oil and gas sectors. Although coal on a per unit of energy basis is a much more intensive emitter, its total contribution lies substantially below that of oil and gas.(4) Emissions also result from the combustion of biomass, as well as from in-house fuel use by the energy sector itself, in generating and processing fuels.

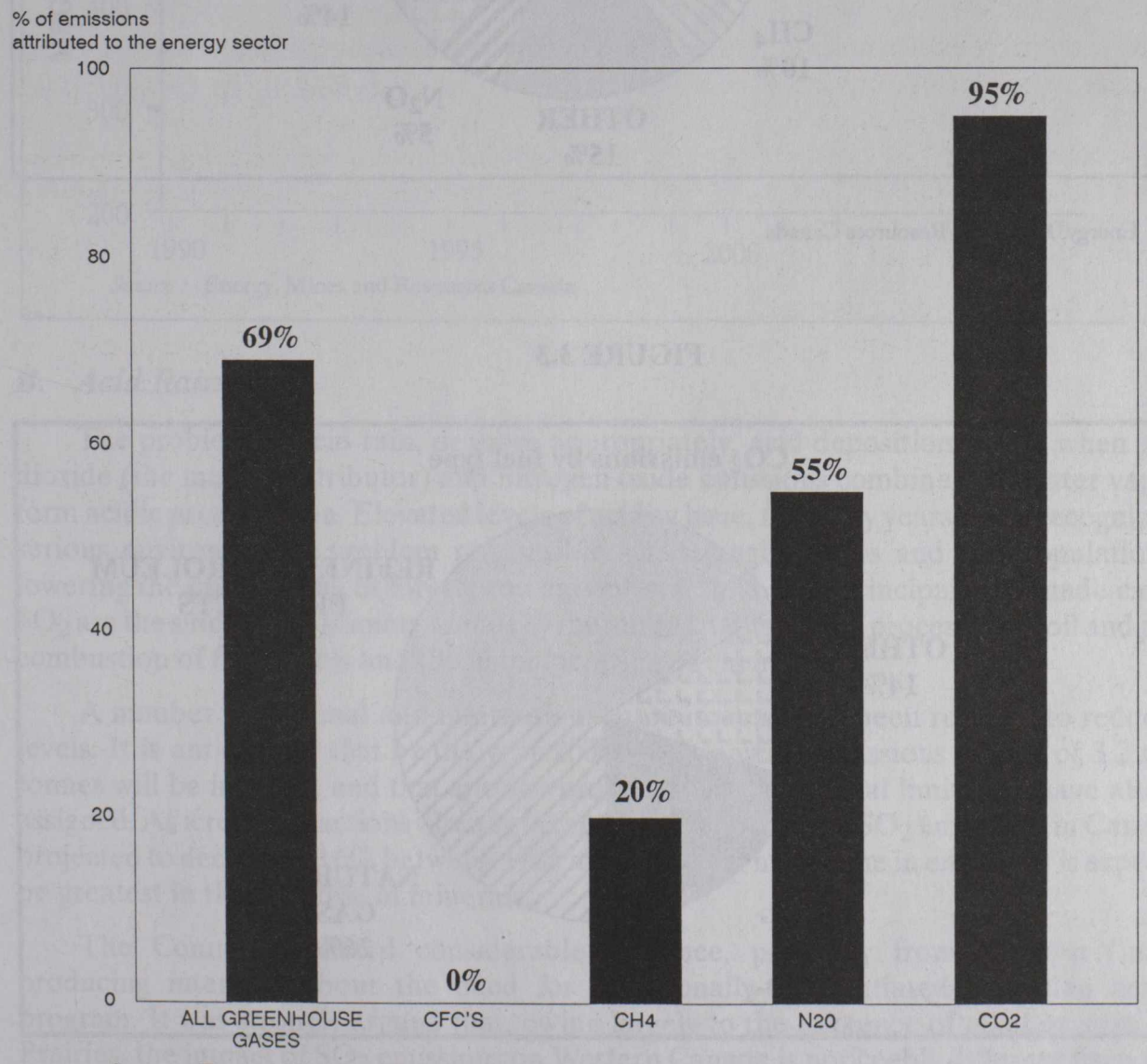
The principal challenge for the Canadian energy sector is to stabilize greenhouse gas emissions at a time when CO_2 emissions, the leading component, are projected, under the government's "business as usual" scenario, to rise steadily, along with an anticipated growth in

economic output and energy consumption. Recognizing the difficulty in meeting irrevocable commitments, the federal government has established a stabilization goal whereby CO_2 emissions would be capped at 1990 levels by the year 2000. The problem lies in the gap of some 88 megatonnes of CO_2 between the projected levels and the 1990 levels (see Figure 3.4). This is the equivalent of a 17% surplus in CO_2 emissions over the 1990 levels. How we, as a nation, are to bridge that gap is the major challenge in the global climate change issue.(5)

In the short run, our ability as a nation to substitute less carbon-intensive energy sources for conventional fuels is limited, although there is some prospect for increased use of "clean" natural gas. If Canada is to make substantial progress in lowering CO_2 emissions, it must improve its energy efficiency performance. Meaningful progress in this area will by no means be easy.

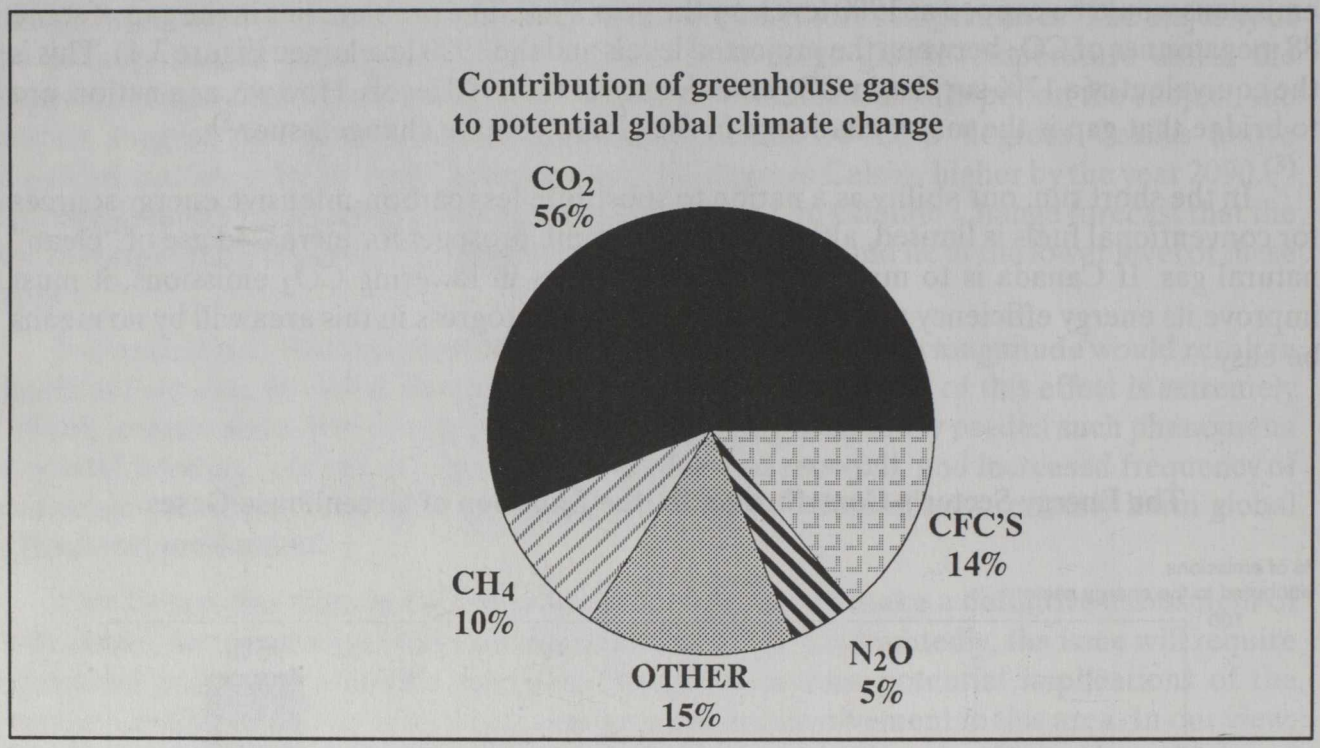
FIGURE 3.1

The Energy Sector's Contribution to the Emission of Greenhouse Gases



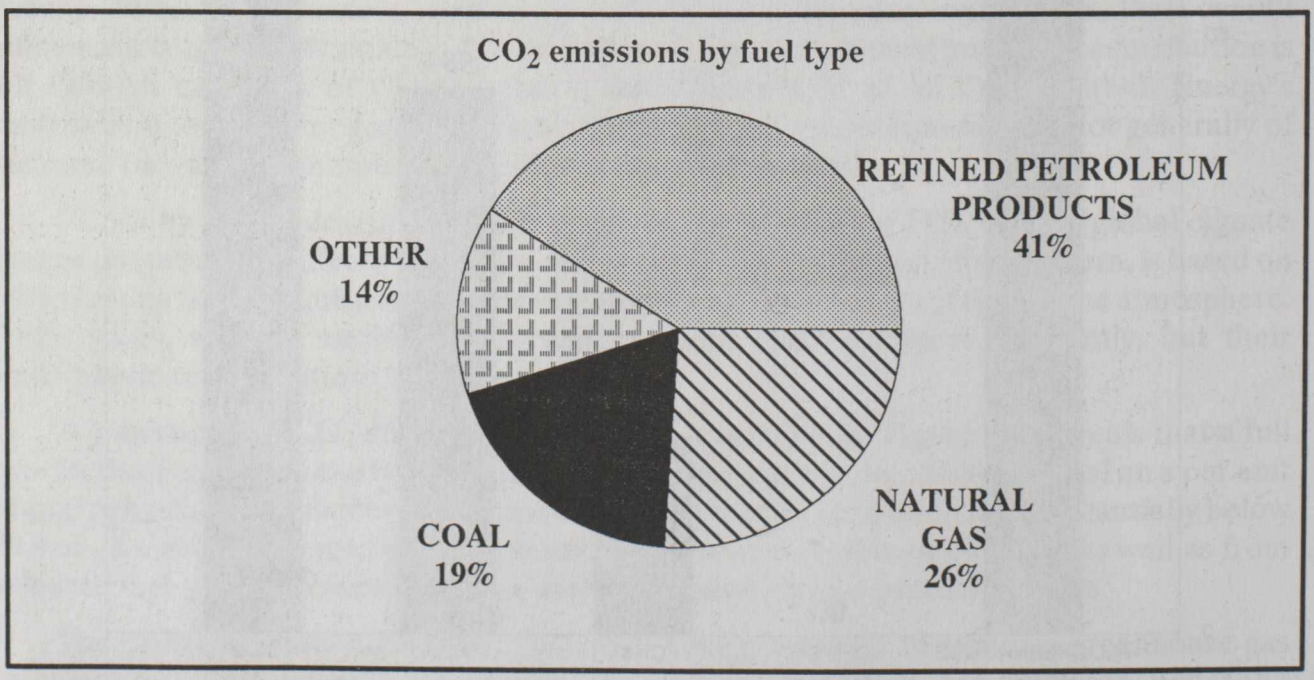
Source: Energy, Mines and Resources Canada.

FIGURE 3.2



Source: Energy, Mines and Resources Canada

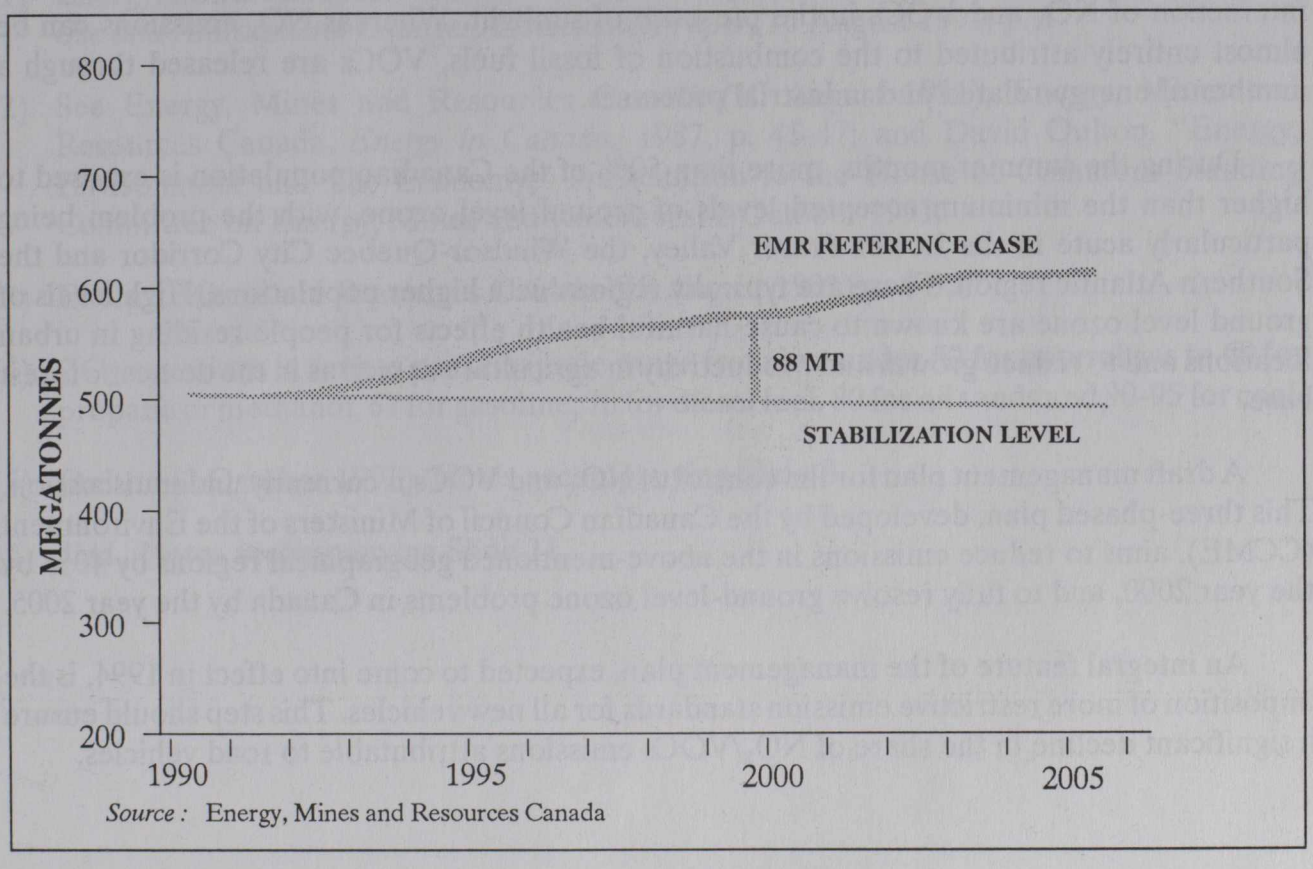
FIGURE 3.3



Source: Energy, Mines and Resources Canada

FIGURE 3.4

CO_2 Emissions in Canada



Source : Energy, Mines and Resources Canada

B. Acid Rain

The problem of acid rain, or more appropriately, acid deposition, arises when sulphur dioxide (the major contributor) and nitrogen oxide emissions combine with water vapour to form acidic precipitation. Elevated levels of acidity have, for many years, been recognized as a serious environmental problem responsible for damaging lakes and fish populations and lowering the productivity of forests and agricultural land. The principal man-made causes of SO_2 are the smelting of primary metals by the mining industry, the processing of oil and gas, the combustion of fossil fuels and the manufacturing of chemicals.

A number of national and international agreements have been reached to reduce SO_2 levels. It is anticipated that by the year 2000, a nationwide emissions ceiling of 3.2 million tonnes will be in place, and that specific provincial and territorial limits will have also been assigned. As a result of actions already taken or planned, overall SO_2 emissions in Canada are projected to decline by 16% between 1985 and 2005.(6) The decline in emissions is expected to be greatest in the smelting of minerals.

The Committee heard considerable evidence, primarily from Western Canadian producing interests, about the need for a regionally-differentiated Canadian acid rain program. It was strongly argued that, owing largely to the existence of alkaline soils on the Prairies, the impact of SO_2 emissions on Western Canada is noticeably different from that on the East and that therefore regional limits should be tailored to local conditions.

C. Ground Level Ozone

Ground level ozone is a major component of urban smog, which is formed by the interaction of NO_x and VOCs in the presence of sunlight. Whereas NO_x emissions can be almost entirely attributed to the combustion of fossil fuels, VOCs are released through a number of energy-related and industrial processes.

During the summer months, more than 50% of the Canadian population is exposed to higher than the minimum accepted levels of ground level ozone, with the problem being particularly acute in the Lower Fraser Valley, the Windsor-Quebec City Corridor and the Southern Atlantic region. These are typically regions with higher populations. High levels of ground level ozone are known to cause harmful health effects for people residing in urban locations and to reduce growth and productivity in agriculture as well as in the domestic forest base.

A draft management plan for the control of NO_x and VOCs is currently under discussion. This three-phased plan, developed by the Canadian Council of Ministers of the Environment (CCME), aims to reduce emissions in the above-mentioned geographical regions by 40% by the year 2000, and to fully resolve ground-level ozone problems in Canada by the year 2005.

An integral feature of the management plan, expected to come into effect in 1994, is the imposition of more restrictive emission standards for all new vehicles. This step should ensure a significant decline in the share of NO_x/VOCs emissions attributable to road vehicles.

ENDNOTES

(1) Energy, Mines and Resources Canada, Efficiency and Alternative Energy Branch, *Energy Use and Atmospheric Change: A Discussion Paper*, 10 August 1991, p. 1.

(2) See Energy, Mines and Resources Canada (10 August 1991); Energy, Mines and Resources Canada, *Energy in Canada*, 1987, p. 45-47; and David Oulton, "Energy, Environment and The Economy," Presentation to the House of Commons Standing Committee on Energy, Mines and Resources, 2 October 1991.

(3) Energy, Mines and Resources Canada (10 August 1991) p. 4-5.

(4) CO_2 emissions in tonnes per terrajoule range from just under 50 for natural gas to 60 for propane or methanol, 67 for gasoline, 70 for diesel fuel, 80 for oil sands and 90-95 for coal.

(5) Oulton (2 October 1991), Notes accompanying Slide 8.

(6) *Ibid.*, Notes accompanying Slide 11.

CHAPTER 4

A REALISTIC RESPONSE TO TODAY'S ENVIRONMENTAL CHALLENGES

When this Committee set out to review the links between resource activity in the energy and mineral sectors and the environment, it identified two objectives. First, we wanted to examine the Brundtland definition of the concept of "sustainable development" as it applies to these two sectors. We felt we could accomplish this by soliciting the views of various associations and witnesses.

Our second, and perhaps more significant, goal was to report on precisely how the industries in question were planning to implement the concept of sustainable development and meet environmental goals and commitments. The question we posed to them was in essence, how can they respond realistically to the environmental challenges they face?

We discovered that, while it was one thing to attempt to define "sustainable development" in general terms, it was quite another to outline what it means in practice—in terms of investment requirements, development of new technologies, environmental and economic impacts and so on. Firms and industry groups, while cognizant of the dominant environmental challenges of the day, in most cases were not able to provide the Committee with the kind of precise information we sought on their possible responses. Instead, most industry representatives admonished the federal government for (a) not identifying more precisely the magnitude of current environmental problems and the likely economic impacts, both positive and negative, of addressing them and (b) not having in place a reasoned and ordered set of environmental priorities and initiatives, ideally formulated from the results of a broadly-based consultation and decision-making process. In their opinion, this process has been sorely lacking until now. They argued strongly that such work must be performed as a necessary precondition for any compilation of a "realistic response."

In essence, the message that we heard was that business needs to know what the government views as the most urgent environmental issues, and what policy instruments it proposes to put in place to address them. It is extremely difficult for business to plan effective environmental responses if the environmental priorities are not set out clearly, and if the enforcement efforts undertaken by government officials do not mesh with the set of established priorities.

Moreover, a national environmental strategy should be developed only after widespread consultation with all the major stakeholders. Only then can it be determined with precision what environmental response would be warranted and what the economic impacts of such a response would be.

During the hearings, the Committee quickly became frustrated with the lack of solid information being provided about new technologies and the financial impacts of environmental initiatives on the industry's bottom line. We understand and appreciate the

many contributions that the energy and mineral sectors have made historically to improving the environment. These are amply recorded in the individual sectoral chapters that follow. Yet, Canadians and their governments are insisting that the pace of environmental action be accelerated. As a Committee, we must conclude that mechanisms must be found to ensure that industry and government respond in not only a timely, but an effective manner.

The remainder of this chapter is devoted to a presentation of how the Committee views the concept of sustainable development as it applies to the energy and mineral sectors. An attempt is also made to provide a general view on how a realistic environmental response could be framed. The sectoral chapters that follow are designed to capture, in a more detailed way, the efforts of energy and mining industries in meeting the environmental challenge. Where information on technological developments and costs was provided to the Committee, it is noted.

THE CONCEPT OF SUSTAINABLE DEVELOPMENT

The Report of the World Commission on Environment and Development (hereafter referred to as the Brundtland Report) characterized sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."(1) To a large extent, this definition is a restatement of the notion that earth's ecology is finite and that the capacity of the environment to absorb pollution is limited.

The Committee agrees that serious abuse of the environment will jeopardize our economic well-being. Ultimately, our prosperity is dependent on the earth's capacity to provide us with the conditions needed to sustain life. As the officials from Environment Canada so aptly put it, "A degraded environment adversely affects renewable resource stocks, can raise input costs and can even reduce labour productivity because of effects on human health."(2) We also recognize that environmental protection is often less costly than clean-up and that to exercise true environmental stewardship, we must increasingly adopt a preventive approach.

We received various interpretations of the concept, but there seemed to be a consensus on two key points. Of primary importance is the notion that the investment capital necessary to implement ecologically sound resource development will only be available if we have a healthy and growing economy. Environment Canada supported this view, noting that "economic growth is a necessary condition of sustainable development."(3)

The second major point, made by Environment Canada and repeated by the representatives from the Canadian Gas Association, is that sustainable development is not a fixed state, but rather a continuous process of change.(4) These comments are derived directly from the Brundtland Report itself, which concluded that sustainable development is "a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations."(5)

We are completely in agreement with these two points of view. Without a doubt, all of us share the desire to preserve and protect the environment in which we live, for the benefit of our children and grandchildren. At the same time, most Canadians also want to ensure that the

country's economic prosperity is not harmed. The concept of sustainable development, if viewed as a process of change and not simply a short-term objective, integrates what, at first blush, appear to be contradictory goals. Indeed, the central tenet of the Brundtland Report is that "Ecology and economy are becoming ever more interwoven—locally, regionally, nationally and globally—into a seamless net of causes and effects."(6)

THE NEED FOR A REALISTIC RESPONSE TO ENVIRONMENTAL DEMANDS

While the Committee clearly acknowledges the close integration of ecology and economy in today's world and subscribes to the concept of sustainable development, we feel that there are a number of particular facts about Canada which must be kept in mind when seeking policies and actions to put the concept into effect.

Historically, Canada's industries have placed great reliance on our abundant sources of energy. We must not lose sight of the many economic benefits that abundant and relatively inexpensive energy and mineral products continue to provide. To us, energy and mining must continue to be a cornerstone of Canada's economic comparative advantage while at the same time contributing realistically to environmental goals.

The point has already been made elsewhere in this report that the energy and mineral sectors make a vital contribution to domestic economic activity, and that economic prosperity is required to provide the initial capital for many environment-enhancing investments. Moreover, Canada is a major energy and mineral exporter in the world marketplace and many of its processes are energy-intensive. We must therefore be mindful of our competitive position. The question is how do we continue to make environmental progress while recognizing these economic realities.

An additional complication lies in the fact that many of the industries in the energy and mining sectors are currently experiencing severe financial difficulties with commodity prices, which are determined elsewhere, in a depressed state. As a number of witnesses pointed out, these industries are not in a position to respond adequately to additional environmental challenges at this time.

The Committee accepts the view that the generation of economic wealth is a critical component in the search for environmental solutions. Accelerated efforts in the area of environmental protection will indeed be much easier to achieve when the energy and mineral sectors are in an improved financial position. However, the Canadian public is increasingly demanding more stringent environmental control over all aspects of activity in these sectors. This being the case, governments and industries together should continue to identify and implement those policies and actions which will result in the most effective environmental investments. In other words, the money which industry does invest in environmental protection should in the first instance be directed at those efforts which are of most benefit both environmentally and economically. Improvements in energy efficiency provide perhaps the best examples of this win-win approach.

Because our economy is so energy intensive, pursuing effective energy conservation and efficiency measures would make Canadian business more competitive over time. We have a lot to gain in this area. In addition to improving our competitive position, seeking to improve

efficiency would encourage and support the development of Canadian conservation technologies and industries and could create employment in communities across the country. While improving the energy efficiency of our own economy we would develop the expertise and the technologies which will be in demand in the rest of the world as other countries grapple with the same environmental issues as Canada. This is the scenario which the Committee wants to see maximized—industry, labour, environmental groups and governments working together to identify and implement the most effective approaches to meeting environmental objectives.

To ensure that the above scenario is realized, the Committee urges the government to seek out and promote those policies which would have maximum salutatory environmental impact but would avoid unbearable economic cost. This is what we believe constitutes a realistic response to the environmental challenge.

ENDNOTES

(1) World Commission on Environment and Development, Our Common Future, Oxford University Press, 1987, p. 43.

(2) Environment Canada, Speaking Notes for the presentation to the House of Commons Standing Committee on Energy, Mines and Resources, 3 October 1991, p. 5.

(3) Environment Canada (3 October 1991) p. 3.

(4) Environment Canada (3 October 1991) p. 3 and Canadian Gas Association, "Natural Gas and the Environment," Brief presented to the House of Commons Standing Committee on Energy, Mines and Resources, September 1991, p. 6.

(5) World Commission on Environment and Development (1987), p. 46.

(6) *Ibid.*, Executive Summary, p. 4, para. 15.

CHAPTER 5

MINING AND SMELTING

THE ENVIRONMENTAL CHALLENGES

Over the years, environmental concerns about mining and smelting have changed. In the past, concern centred primarily on issues related to surface disturbances produced by such activities as the clearing of land, the removal of forests, the cutting of seismic lines, and the creation of gravel pits. More recently, interest has grown in impacts that are less noticeable but more widespread, such as water drainage from disturbed sites, and the resulting erosion and lake and stream pollution. More subtle still are the atmospheric results of dust and gases emissions produced by development activities. These emissions are now spreading far beyond their source regions, crossing international boundaries and provoking global concern.

In the course of its hearings, the Committee heard testimony on the main environmental concerns challenging the mining industry:

- surface disturbance during the exploration, mine development, and operational phases;
- the disposal of waste rock, low-grade ore, and tailings which react with air and water to generate acids and dissolved metals (acid mine drainage);
- the disruption of surface and underground watercourses, and the discharge of acid mine drainage to them;
- the generation of sulphur oxide gases during the smelting of sulphide ores, and their discharge to the atmosphere, which leads to acid rain.

The Committee also heard testimony on a number of effects of lesser magnitude, but perhaps of equivalent importance, including: the release of carbon dioxide, ozone and other greenhouse gases from fuel combustion, blasting, mineral oxidation, and especially cement manufacturing,[1] and the consumption of prodigious quantities of energy, particularly for such operations as potash drying, which can consume 260 kWh for each tonne of ore processed.[2]

Conventional mining activities comprise: exploration, site development, extraction, benefication, and extractive metallurgy phases; they are followed by decommissioning operations to restore a site after an ore-body is exhausted. At each stage there are various impacts on the environment, all of which present challenges to the mining or smelting industry.

The exploration phase, for example, involves the use of a variety of techniques for locating and delineating ore bodies. Some techniques put much more stress on the environment than others, and the effects can be exacerbated if the activities are carried out carelessly or if

inadequate attention is given to subsequent "cleaning up" and reclamation. Mining methods and sites for waste heaps, mills, tailings areas, and smelters must be chosen so as to minimize environmental problems and to facilitate decommissioning. The increasing use of surface mining methods, which produce greater surface disturbance and a larger volume of waste rock, is also putting more pressure on the environment. Although the average mine has an operating lifetime of about 40 years, many ore-bodies are exhausted much sooner, and the associated mining and milling activities are moved to new locations. Thus, according to some authorities, all mine structures should be considered temporary, and be constructed with minimum disturbance to the site and maximum ease of removal at the completion of the operation.(3) One estimate concludes that the rehabilitation of abandoned minesites and upgrading existing mines to comply with new environmental legislation could cost over $80 billion.(4)

Compounding the direct disturbance caused by mining activities are the secondary effects due to subsidence and wind and water erosion which are spread over adjacent land areas. Such disturbance includes the surface storage of waste materials, many of which are reactive when exposed to water and air, producing acid drainage which will dissolve metals in the waste and produce a toxic effluent, capable of polluting adjacent water bodies.

While some air pollution results from wind erosion of land exposed during exploration, site development, and extraction operations, the major effect of mining on air quality results from oxidation of base metal sulphide ores during smelting to produce sulphur oxide gases. These undergo chemical changes in the atmosphere and result in acid rain. Wind erosion from waste heaps, fugitive emissions from milling, and smelting operations all contribute minor amounts of many toxic elements, such as antimony, arsenic, cadmium, copper and nickel, to the atmosphere.(5)

It is also true that mining releases considerable amounts of greenhouse gases and particulate matter, and thus contributes to atmospheric "pollution" on not only the local, but also the regional and global scenes.

More recently, concerns have arisen within some segments of society about some effects of mining on the natural environment that may have little immediate economic impact. Potential damage to resources such as clean water and air, endangered spaces and wilderness are leading to major confrontations that will not be resolved easily. The Committee heard a great deal about the need to internalize the costs of degrading these resources, the quantification of which, as is the case for the energy sector, represents a major challenge to the mining industry.

The Canadian Nature Federation (CNF) is concerned with the protection of "species and ecosystems, with an emphasis on biodiversity, completion of the National Parks system, the protection of 12% of Canada's lands and waters and the protection and restoration of endangered species and their habitats."(6) CNF feels that the concept of sustainable development is entirely consistent with this goal, but stresses that decisions on future mineral development must be integrated with the selection of sites to complete the network of National Parks and protected areas. In its appearance before the Committee the CNF also urged that there be broad public consultation in completing the network and, since conflict is inevitable, that a process for conflict resolutions be established.

The future will likely see even more pressure put on the mining industry to moderate its activities so as to reduce its harmful impacts on the environment. Not only will the industry have to deal with increasing environmental pressure on existing operations, it will also have to plan for new operations and even new minerals. Recent finds that are likely to be developed in Ontario, Quebec and British Columbia include graphite, wollastonite and garnet. It is entirely possible that operating these new mines may present new environmental problems.

While society wants and needs the products of industrial development, it seems unwilling to sacrifice the clean and unspoiled environment that it has, until recently, taken for granted. Thus, mining and smelting activities will be forced to walk a narrowing path between immediate economic benefits and ecological cost, as society charts a course towards "sustainable development."

INDUSTRY'S RESPONSE TO THE ENVIRONMENTAL CHALLENGES

A. The Past

Like the rest of society, most mining people have drastically changed their approach to the environment over the past two decades. One sign of this is seen in the terms of reference for the Mining Industry Council of Canada (MITEC), which was established in 1987. MITEC's mandate is to encourage pre-competitive, cooperative research amongst member companies, and between companies, governments and universities. Its projects so far have tended to be rather small and to be focused on specific problems, some environmental, such as the treatment of effluent streams so as to reduce water content and volume of sludges requiring containment. MITEC is also involved in research to find alternative uses and markets for sulphur as continued lowering of SO_2 emissions brings more of this commodity on to the market.(7)

A second joint program deals with the largest single environmental problem facing the mining industry today—acid mine drainage. The Mine Environment Neutral Drainage (MEND) program established in 1988 is a cooperative program involving the Canadian mining industry, the federal Canadian Centre for Mineral and Energy Technology (CANMET), Environment Canada, Indian and Northern Affairs and the provinces of British Columbia, Manitoba, Ontario, Quebec and New Brunswick. The research activities in the MEND program focus on prediction, prevention and control, treatment, monitoring and international liaison on acid mine drainage.(8)

The adoption of an "Environmental Policy" and the development of a "Guide for Environmental Practice" by the Mining Association of Canada (MAC) are both very positive signs that the MAC, and the mining industry in general, are seriously committed to environmental responsibility. The MAC was, in fact, the first national mining body to adopt such an environmental policy. It is encouraging to note that the mining industry is becoming involved in such government activities as the drafting of Canada's Green Plan, the *Federal Environmental Assessment Review Act* and Ontario's Environmental Bill of Rights and, in particular, the development of a standing committee, with Environment Canada, to enhance

cooperation between that department and the mining industry. In its presentation to the Committee the MAC outlined a number of additional actions, which it and other mining associations feel further demonstrate their desire to meet environmental challenges head on.(9) The fact that many of the larger companies now have environmental officers and committees is certainly an additional indication of the importance with which they now view environmental matters.

The MAC is very active internationally. In addition to its participation in the International Workshop on Heavy Metals and Human Health and in the preparations for the 1992 UN Conference on Environment and Development, it has promoted an international approach to dealing with environmental concerns through the formation of the International Council on Metals and the Environment.

The Prospectors and Developers Association of Canada is also preparing its own "Environmental Code of Practice" for exploration activities.(10) Such a code is sorely needed, since exploration touches such a large area of the country. One estimate, for example, attributes one successful operating mine to every 5,000 prospective sites.(11) Obviously, any lack of consideration for the environment during the exploration stage can have widespread environmental impacts.

At the provincial level, the Saskatchewan Mining Association, in cooperation with the Department of Environment, has developed a set of Mineral Industry Environmental Regulations, which the MAC considers "workable and acceptable." The Saskatchewan Uranium Association is cooperating with the Department of Environment in addressing the management of acid mine drainage, while the Saskatchewan Potash Producers Association is sponsoring research dealing directly with the major problem of salt tailings.

The Quebec Mining Association has recently produced a detailed Environmental Report on its mining industry. It summarizes mining activities in the province and their effects on the environment and presents recommendations for governments and the mining industry, together with a three-year plan of action. The recommendations include an "environmental evaluation" assessing each mine's environmental status, and a "savings plan" for the decommissioning costs of closing down mining operations.

The Ontario Mining Association has published an "Environmental Legislation Manual for the Mineral Industry in Ontario" and held a series of seminars on environmental legislation and compliance at several locations within the province. The Association has issued an Environmental Policy Statement, emphasizing its commitment to environmentally sustainable economic development, and has allocated 30% of its budget to environmental projects.(12) Further examples of its commitment are its involvement in the Municipal Industrial Strategy for Abatement (MISA) and the Mine Environment Neutral Drainage programs and the environmental compliance records of many of its members.

In British Columbia, an "Acid Mine Drainage Task Force" was established in 1986 to bring together government, industry and academia in a search for effective solutions to the problems associated with acid mine drainage (AMD) in that province and to transfer that knowledge to the industry.

Noranda's "environmental auditing program," Falconbridge's success in meeting Ontario's "Countdown Acid Rain" goal, Cominco's pioneering control of sulphur gases and its contribution to the "Lead-Acid Battery Collection, Reuse and Recycling Program," and Nerco Con Mine's new arsenic sludge stabilizing technology are all excellent examples of the efforts made by the industry itself to meet environmental challenges. Inco management and workers have together formed an Environmental Awareness Committee, the first of its kind in Canada. The committee's goals will include examining environmental laws and regulations, and making recommendations on safety, health and environmental issues applicable to their operation.(13)

B. The Present

In general, the mining industry is doing a fair job of dealing with current environmental challenges. Most mining companies are doing their best to comply, within the limits of financial feasibility, with the highly complex tangle of environmental legislation and regulation that has grown up over the past few decades.

There is, of course, a wide range of views, even within the mining industry, on environmental issues. To use the words of a senior mining company official, the environmental management activities of mining companies range from "red-necked reactionary at one end to clean and green at the top."(14) In between these extremes, he defines: companies that pay lip service to environmental matters, companies that are concerned enough to have developed some environmental policies, and proactive companies that have developed codes of conduct and standard designs and procedures for environmental matters. This official considers the various categories as a sort of evolutionary scale along which companies move as they develop more environmental responsibility, especially in response to public demands for action on environmental matters and to the need to remain competitive in world markets and the introduction of better decision-making processes. Efforts such as the MEND and MITEC programs and others described as "past" accomplishments continue to foster such movement and will continue to do so.

The mining industry, however, still has considerable work to do with respect to environmental cleanup. As society decides what it wants within the Brundtland Commission concept of sustainable development, and enshrines this clearly in legislation and regulation, the mining industry seems prepared to accommodate it. This is especially true if actions are agreed to and implemented internationally.

A general complaint by the industry is the complexity of the legislative/regulatory regime, and the differences, and sometimes inconsistencies, between jurisdictions. The industry feels that a lot of time is wasted dealing with the bureaucracy of environmental control that could be better spent on environmental control itself. Working with government to evolve a consultative process acceptable to all remains a major goal for this industry.

The Committee has discovered in the course of its hearings that, even though a great deal of progress has been made, a number of issues still have to be resolved. For instance:

- The Green Plan goal of setting aside 12% of Canada's total territory as protected space needs to be clearly enunciated. Decisions will have to be made not only on where to locate the protected areas, but to what degree each will be protected.

Should mining be allowed in these areas at all? If so, under what specific conditions? Should only reclamation be required, or complete site restoration? Some mining interests view minerals as being almost infinite resources, but at the same time think society should "continue to make available for mineral exploration as much land as possible."[15] Surely, even if all of the projected 12% of the country were completely excluded from mining, there would be enough left to supply the industry for a long time to come. This is especially the case as mining potential is used as one of the considerations in choosing the protected areas. The National Land Use Database (NATLUS), developed by the Ministry, Industry Land Use Committee (MILUC) and the Mineral Policy Sector of Energy, Mines and Resources, will provide a very useful tool for the planning of future mineral development.[16]

- Can "clean and green" mines be as competitive as others? If not, how can the extra costs of environmental protection be recovered? Can they be built into the costs of the products? And if so, how can potential benefits be achieved?

- What time scales are reasonable for the industry to respond to environmental problems?

- What degree of site reclamation is reasonable? Can EIA procedures be streamlined to reduce jurisdictional overlap and the consequent confusion and costly delays in recovering exploration costs?

- To what extent should presently abandoned mine sites be cleaned up and who should pay for the clean-up? Most of them are not only aesthetically undesirable, but represent loss of ecological habitat and contribute to water pollution on a continuing basis. Given that, in many instances, the original operator of the now-abandoned mine site no longer exists or cannot be found, what ways exist to encourage the clean up of these sites? Who shares the responsibility for clean up? Under what conditions, and to what extent, should governments provide financial incentives to accomplish this cleanup?

- Can legislation and regulations be drafted that will provide consistent encouragement to the mining industry to pursue environmentally sound operations?

and, finally,

- Can a way be found to help smaller companies, in particular, find their way through the complex regulatory and jurisdictional web?

C. The Future

As indicated above, there still appear to be a number of economically feasible ways in which the mining industry can reduce its environmental impacts. As pointed out in the Northern Miner,[17] the environmental protection "clouds" may have some silver linings, such as: improvements in mine operating performance; competitive differentiation between compliers and non-compliers; improvements in shareholder relations; and higher employee morale.

Action could be taken to promote higher levels of recycling of mined materials, for example. Most mined materials are not really consumed, but instead are used for a while and then discarded. The environmentally harmful effects of recycling are usually much less than those of mining native ore. A considerable amount of recycling is carried out already, where it is economical to do so. This could certainly be increased, for example, if the problems associated with establishing a collection infrastructure could be reduced. Further, it is vitally important that new and sustaining markets for recycled products be fostered. Manufacturers are beginning to design more products with ease of separation and recycling in mind and this is viewed as a positive trend by the industry.(18)

The industry might also consider carrying out more re-mining of wastes and tailings, since these materials are more accessible than the original ore. A move to more re-mining would, of course, depend on favourable economic conditions and on the availability of improved extraction technology.

Mining companies already make extensive use of remote sensing and geographic information systems to minimize the environmental impact of exploration, and, as new, even more sophisticated technologies emerge, this trend is sure to continue. Similarly, companies will continue to improve on extraction techniques so that the amount of waste rock generated at a mine is kept to a minimum. The increased use of backfilling methods will also help to reduce the acid generation that occurs when the waste rock is brought to the surface.

By expanding alternative uses for the inevitable residuals from mining activity, companies can again move to reduce the impact of their operations on the environment. Sulphur is a good example. Canada already accounts for about 15% of world elemental sulphur production, and is a major producer of sulphuric acid as well. Considering that the major world use of sulphur is for fertilizer, and that its discharge into the atmosphere as sulphur dioxide is one of mining's most serious environmental problems, there is every reason for Canada to work toward capturing an even larger share of both the residual sulphur and world markets for elemental sulphur.

In the sector's efforts to remain competitive in world markets, many new methodologies are being developed to make mining operations more efficient. These may have direct environmental benefits, but even if they do not they may produce cost savings that can, at least partially, go toward environmental protection. The key players in these developments are the industry itself and equipment manufacturers in Canada and abroad. Much of the work is being guided by research carried out under the auspices of groups such as the Canada Centre for Mineral and Energy Technology, the Canadian Centre for Automation and Robotics (CCARM), the Mining Machinery and Equipment Manufacturers Association of Canada (MMEMAC) and the Mining Industry Technology Council.

Some examples of new mining technologies that are gradually being introduced into the workplace are listed below:

- Improvements in mining machinery, sensors, data collection facilities and communications systems, as well as computer-control for services such as electrical systems, ventilation, pumps, and hoists.

- The use of geographic information systems for the mapping of ore bodies, together with locally-sensed and video data to permit more selective underground extraction, leading ultimately to complete robotization of operations. A major Canadian uranium mining company, Cameco, is building remote-controlled mining methods into its new Eagle Point mine in northern Saskatchewan.

- The use of controlled blasting to reduce ore dilution with waste rock. For example, a new technique, called plasma blasting, which uses a giant "spark" to fracture an orebody, is being investigated by Noranda.[19] This methodology is safer than explosives, eliminates noxious gases and fly rock, and reduces the need for complete evacuation of the area. It will have a great potential for use with continuous-mining and *in situ* leaching.

- The development of continuous mining methods to replace the conventional drill-blast-muck methods where possible.

- The greater use of computer control and biological methods to assist in treating mine wastes, mine drainage and tailings. The concepts of ecological engineering, discussed before the Committee by Boojum Research Limited, appear to hold considerable promise.[20, 21]

Progress is already noticeable in some areas; waste from surface-mining operations has been reduced and some underground operations have been automated. In the U.S.A., both underground and surface coal mines have almost doubled productivity (in terms of tons of output per man-shift) since 1977.[22] A similar trend has been noted in Canada.[23] There was relatively little change from 1961 to 1981, but since then there has been a steady rise, amounting to a doubling in productivity. In a recent article on the outlook for Canadian coal mining in the nineties, the authors predicted that the trend towards continuous mining and conveying systems would continue as pits became deeper, hauling distances longer, and competition from other coal-producing countries tougher.[24]

The Committee commends the mining industry in general for realizing significant productivity gains and notes that the time period over which such gains were accomplished was one in which environmental regulations became increasingly more stringent. We urge the industry to again redouble its efforts to improve productivity, at least in part, to help it meet its current environmental challenges.

According to a recent editorial in the *Northern Miner*,[25] what is needed is a return to the days of innovative thinking 30 years ago, when Canada led the world in developing new mining methodologies. Now, according to the author, most mining is standardized, and focuses on the use of large machinery and bulk-mining methods to deal with orebodies of increasingly lower grade. The article proposes: "A possible solution is a wedding of 21st century technology and the mining smarts of our grandfathers. The industry must go for the grade and the selective mining practices of 50 years ago, coupled with the continuous mining techniques now being designed."

As a world player in the production and export of mineral resources, as well as a leader in many areas of mining technology, there is no reason why Canada cannot develop world-class environmental control technologies from which it could subsequently gain substantial economic benefit.

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CHAPTER 6

NUCLEAR ENERGY

THE ENVIRONMENTAL CHALLENGES

The main environmental challenges facing the nuclear power industry arise from its dependence on the mining, concentration, use and disposal as waste of extraordinarily persistent and poisonous material. Some of the most significant of these challenges will be considered below. However, from the more limited perspective of global climate change caused largely by the combustion of fossil fuels, the nuclear industry initially appears to offer some distinct advantages. At the plant level this form of electricity generation is free from emissions of CO_2, NO_x and SO_2 and other greenhouse gases. Even if one considers the total nuclear fuel cycle, including the quantity of such emissions attributed to the combustion of fossil fuels used in constructing the nuclear facility and in mining, processing and transporting the nuclear fuel and then storing the wastes, nuclear energy does not face the major challenge of conventional thermal generation; reducing greenhouse gas emissions.(1)

If one were only looking at the problem of global climate change then, nuclear power would appear to offer an important option as a replacement for fossil-fuelled electricity. However, since nuclear power is used almost exclusively to generate electricity, its role in reducing atmospheric emissions caused by the combustion of all fossil fuels is necessarily limited to the electricity generation sector. In addition, because nuclear power generation is expensive, it may be a remarkably inefficient means of reducing emissions that cause global climate change. Dollar for dollar, reducing energy demand by stimulating energy efficiency and conservation is, in the short-term, unquestionably a far more promising means of addressing this problem. In addition, and as already stated, the nuclear option also has its own set of environmental challenges. As one might expect, the views of the industry and the views of other interested parties differ substantially on just what these are.

Appearing before the Committee, industry representatives focused on two issues which, although they are related to the environment, constitute financial, rather than environmental, challenges. These challenges were the financial difficulties associated with meeting (a) environmental assessment requirements, and (b) new limits on radiation exposure promulgated by the Atomic Energy Control Board (AECB).

A. Environment Assessment Requirements

The Canadian Nuclear Association (CNA), argued strenuously that the costs and schedule delays associated with performing environmental assessments for new projects places unreasonable economic demands on existing and proposed projects. The industry claimed that the environmental assessment processes currently required in Canada are too

wide-open. According to industry representatives, the hearings tend to include consideration of issues outside the control of proponents such as past performance of the industry, the use of the materials to be produced, the advisability of industry expansion and so on. This is seen as a particular problem in hearings on uranium mine proposals.(2) The industry representatives said they would like to see a tightening up of the terms of reference for environmental impact assessments. The AECB, on the other hand, contends that the new *Federal Environmental Assessment Review Act* (FEARA) includes provisions that will ensure that this "wide open" hearing process is more focused.(3)

In its brief to the Committee, the CNA provides some detail of the complex process for completing the environmental assessment of a proposed uranium mine.(4) It notes that in the past the AECB exercised its legislative mandate on environmental assessments by participating in and accepting the findings of the equivalent provincial process. The recent court rulings on the Rafferty-Alameda Dam project have forced a reassessment of this practice as the federal government must now make its own determination. Fears that this would lead to a duplication of the entire assessment process were alleviated when it was decided to appoint a joint federal-provincial environmental assessment panel to examine the proposals for new uranium mines in Saskatchewan. The enthusiasm for this approach has been tempered somewhat, however, by the fact that it took some seven or eight months for the joint panel to be named. Hearings could take another 18 months or longer. As a result of the requirement for more participation in the environmental assessment process, AECB has recently increased its assessment fees for a siting or for a uranium mine construction licence to $1.608 million annually, as part of its cost recovery program. The industry representatives argued that these fees, as well as the delay involved, represent significant and unreasonable costs to the industry.(5) By contrast, other intervenors claimed that the nuclear industry has, for years, effectively enjoyed an almost total exemption from Canada's environmental regulatory processes. Instead, they argued, regulation of the industry has been based less on environmental imperatives than on the technical ability of the industry to meet regulations established by the AECB—an organization which its critics contend is not effective because it is not truly independent of the industry it is meant to regulate.

Environmental impact assessments are not the only regulatory challenge facing the nuclear industry, which is probably the most closely regulated industry in the world. The activities of the Canadian nuclear industry are regulated primarily by the AECB, a departmental corporation created under the terms of the *Atomic Energy Control Act, 1946*. The Board reports to Parliament through the Minister of Energy, Mines and Resources and its mission is to ". . . ensure that the use of nuclear energy in Canada does not pose undue risk to health, safety, security and the environment."(6)

The AECB is responsible for developing regulations to govern all aspects of the development, production and application of nuclear energy. This includes jurisdiction over the mining and processing of prescribed substances; their production, import, export, transport, possession, ownership, use and sale. The Board exercises its authority by defining the safety standards that facilities must meet, by assessing the ability of licence applicants to meet these standards and finally, after a licence is granted, by inspecting facilities to ensure compliance.(7)

In other countries the nuclear regulatory agencies tend to establish regulations detailing the equipment to be used, its method of installation and the operating procedures that must be followed. In Canada, the AECB instead establishes health and safety standards for nuclear facilities. It then falls to the applicants to convince the Board that their design will be able to meet the standards and that their proposed operations will meet strict emission limits under normal conditions and under commonly-occurring upset conditions. The Board develops its standards and sets its limits based on rules of good practice, dose limits, emission limits and other internationally accepted safeguards. The Committee applauds this flexible approach.

Because of the unique manner in which the AECB operates, the industry points out that the entire design of a nuclear plant is in response to environmental protection criteria set out by the AECB. In addition, the industry notes that not only does it meet AECB requirements, but it seeks to surpass them. For example, operators have set an internal limit for routine emissions of radioactivity which are just 1% of the allowable releases established by the Board.

The Committee is interested in ascertaining the costs of environmental regulation; while we did not receive any such information on these during our hearings, a number of other sources do provide some idea of the amounts involved. For example, one study gave the following approximate estimates of the cost of environmental compliance to the nuclear power industry.

(a) Impact of regulation on capital cost of the Pickering B station: Capital cost attributed to radiation, health, safety and environmental considerations was $309.5 million (or 10% of the total capital cost). Of this amount, $196.9 million was estimated as the cost that would have been incurred by a prudent but unregulated operator; $112.6 million was estimated to be the marginal cost of regulation.

(b) Impact of regulation on operation of Bruce B reactors: the total cost of radiation, health, safety and environmental measures was estimated at $30.7 million in 1980, or 8.9% of the total cost of producing electricity that year. Of this amount, $15.6 million was estimated as the cost that would have been incurred by a prudent but unregulated operator; $15.1 million was estimated to be the marginal cost of regulation.[8]

Before the implementation of its cost recovery program, AECB investigated the financial burden it would impose on the uranium mining industry. In 1990, the AECB provided the following information on the costs to industry, the secondary impacts and the impacts on competition, labour and trade:

COST TO INDUSTRY (ANNUAL)		
	Costs Used for Public Consultation	**Costs due to Regulations**
Ontario	1,792,325 $	2,106,890 $
Saskatchewan	1,498,520 $	1,580,175 $
Northwest Territories and Newfoundland	40,000 $	48,400 $
TOTAL ANNUAL AECB REVENUE	3,330,845 $	3,735,465 $

Secondary Impacts

The combination of depressed uranium markets and continued low uranium prices could delay approximately $25 million of development of new properties over the next two years and extend present shutdowns. This will reduce the demand for services provided by companies that support the mining industry. AECB licensing fees will exacerbate these situations. The greatest impacts will be felt in Saskatchewan, where the new developments will take place.

The mining companies claim that the ore cut-off grades will be increased to ensure continued viability of mining operations. The low-grade ore will be placed into the tailings and will be lost as a source of energy.

Competition, Labour and Trade

There will be no significant impact on domestic market competition if the electric utilities continue to buy Canadian uranium; however, if they do not do so the impacts could be serious. Uranium mines in Ontario, which have high production costs, will feel the impact much more than those in Saskatchewan, which have higher ore grades and lower production costs.

The industry claimed that the AECB licensing fees would cause further layoffs, estimated at as many as 100 people in the short term in a sector that currently employs approximately 5,000. In the longer term, more layoffs could be expected if the companies were unable to renegotiate existing contracts.

The industry further claimed that the introduction of fees would harm Canadian uranium producers in competing with international producers. The international uranium market is severely depressed, with short-term prices at their lowest point ever and long-term prices in decline since 1980. The AECB analysis of the financial information indicates, however, that firms would not harm their international market if they did not pass on the cost of the fee to the customers, something that could be done without hurting the firms' financial positions. It is predicted that the international demand for uranium will increase within the next few years.(9)

B. AECB Limits on Radiation Exposures

The second challenge identified by the industry representatives affects mainly the uranium mining sector. The industry questions the economic feasibility of insisting that the uranium mining industry meet the new AECB limits on radiation exposure of mine workers. A CNA official told the Committee that new limits, and in particular the way in which they are being applied, could result in the complete phase-out of uranium mining in Canada.(10) While no definitive assessment has yet been done of the added costs of more stringent dose limits, a CNA task force which examined the issue concluded that the mining sector would be particularly hard hit if the AECB went ahead with its intention of implementating a strict one-year dose limit. The Task Force stated in its report, that ". . . without the flexibility permitted by averaging, [the limit] would impose significant extra costs on the mining companies with no obvious benefit in reduced risk to their workers."(11) Similarly, a CAMECO (Canadian Mining and Energy Corporation) official has stated that ". . . even the

western mines may have difficulty meeting the new limits. The estimated cost of the increased protection is at $4m per person Sievert, and would add several dollars per lb to the current $8 per lb price of uranium. The impact of possible mine closures must be considered before new regulations are made."[12] In order to allay fears about its ability to handle this financial obligation, however, CAMECO subsequently stated, in response to comments made before the Committee, that it is, in fact, capable of continuing operation under the new limits, although it made no mention of the cost at this time.[13]

The new AECB limits originated with the International Commission on Radiological Protection (ICRP), which published a document (ICRP-60) containing new recommendations on radiation protection. These recommendations were based on the latest radiation risk estimates derived from the re-analysis of the atomic bomb survivor data and other epidemiological studies. The new risk estimates are significantly higher than those issued earlier.[14]

Briefly, according to industry representatives, the major changes proposed by the AECB which are of concern to the industry are:

(a) Atomic Radiation Workers (ARWs) are now defined as those workers receiving an occupational radiation dose of more than 1 mSv per year.

(b) An ARW must not receive an occupational radiation dose of more than 20 mSv per year. The previous limit was 50 mSv per year.

(c) The occupational radiation dose must be estimated on the basis of total risk. This means that, in addition to external doses, the dose due to inhalation or radioactive gases and dusts must be considered as part of the 20 mSv annual dose limit. The previous regulations did not require inclusion of the gaseous and dust components, although each was separately regulated.

The CNA is concerned that:

(a) That ICRP-recommended occupational dose limit is 100 mSv every five years, which the AECB has interpreted as an annual limit of 20 mSv. The ICRP limit allows a greater degree of flexibility in the occupational exposure of workers than does the AECB limit.

(b) The requirement to meet both a lower dose limit and to consider total risk may be impossible for some mines (particularly the underground mines) to meet. It is worthwhile noting, however, that the Province of Saskatchewan already requires the mining industry to use a total risk formula.

(c) It may be very difficult to estimate accurately the occupational dose to workers from the gaseous and dust components.

While the Committee confesses its at-best amateur status in these matters, it is persuaded of the need, when dealing with untreatable poisons of the sort being regulated, to err on the side of caution.

The Committee heard a number of presentations from intervenors who were not associated with the industry. These concentrated directly on some of the environmental challenges facing the industry. The major issues raised include the following, each of which merits additional discussion.

(a) Routine (permitted) tritium releases from nuclear reactors;

(b) Routine (permitted) releases of radioactive liquid effluents from nuclear reactors;

(c) Extremely long-term management of radioactive wastes;

(d) Management of uranium mine tailings;

(e) Decommissioning of nuclear facilities.

C. Routine (Permitted) Tritium Releases from Nuclear Reactors

CANDU reactors use heavy water to cool the fuel and thus generate tritium as a by-product (tritium is the result of neutron absorption by heavy water). Some tritium is released into the environment and these emissions are regulated by AECB. Most nuclear reactors outside Canada operate with normal (or light) water, which contains only trace amounts of heavy water. For those reactors, tritium production is not generally a regulatory concern, so tritium emission regulatory limits may not exist in some jurisdictions. Administrative limits may exist in these jurisdictions, but these are based on existing or expected inventories and are necessarily much lower than the Canadian regulatory limits.

Canadian-derived emission limits for tritium are established by the AECB according to what it contends would be conditions posing a negligible health risk to the population. Operating targets are generally 100 times smaller.

During the course of the Committee's hearings allegations were made of an association between tritium emission and the incidence of leukemia near nuclear power plants located in Ontario. Results published in 1991 from a study conducted for the AECB by staff from the Ontario Cancer Treatment Foundation and from the University of British Columbia could find no sufficiently statistically significant correlation to support or refute this allegation.(15) The Committee is of the opinion that continued judicious concern about this issue is warranted.

D. Routine (Permitted) Release of Radioactive Liquid Effluent from Nuclear Reactors

Intervenors brought to the Committee's attention the fact that in 1988 a private citizen (David McArthur), distributed to the news media a report that he had detected an association between waterborne tritium releases from the Pickering nuclear power station, and birth defects and infant mortality in the area.

A subsequent AECB study of the same data, by contrast, concluded that the rates of infant death and birth defects were generally no higher in the study population than Ontario as a whole.(16) The AECB report concluded that any possible relationship between observed

elevated rates of Downs Syndrome, and reactor tritium releases was weak and contradictory. In part, this conclusion rested on the fact that there was another area of statistically significant incidence of Downs Syndrome elsewhere in Ontario where there is no reactor. This finding is, of course, inconclusive, but the Committee would again urge that continued judicious concern is warranted.

Ontario Hydro has a technical group responsible for evaluating new technologies for controlling routine waterborne and airborne releases from nuclear stations, and for their application to CANDU plants. Although small-scale technologies may exist for emissions reductions, they have generally not been adopted to-date, because of economic considerations or difficulties in scaling them up to meet power plant requirements.

E. Extremely Long-Term Management of Radioactive Wastes

Radioactive waste is an inherent by-product of every phase of the nuclear power cycle, including the front end (mining, milling, fuel fabrication), plant operation, disposal and decommissioning. Although very large volumes of waste are produced by the front end operations, in terms of radioactivity, most of the waste, approximately 100,000 times more, is a result of the operation of the reactor.

Waste generated during the operation of a reactor is classified as either high level waste (HLW) or low level waste (LLW), depending on its specific radioactivity. HLW consists of the irradiated fuel; LLW consists mainly of contaminated clothing and miscellaneous items.

The volume of irradiated fuel produced by nuclear reactors in Canada over the past 30 years is relatively small in volume, consisting of approximately 2500 m^3, or the equivalent of a 13.5 m side cube, unpackaged.[17] However, it must be recognized that although the volume of waste is rather small, the waste itself is highly radioactive and thus enormously poisonous. It therefore requires special treatment to keep it isolated from the environment for many hundreds of years. The level of radioactivity of that HLW decreases with time; after 10 years, the level is approximately 10 times less. After 100 years, the level of radioactivity in the fuel is approximately 100,000 less than when it was first removed from the reactor, though it remains dangerously radioactive.

As the radioactive elements in the irradiated fuel decay, heat is generated and must be removed in order to maintain the integrity of the fuel elements. For this reason, HLW is initially placed in wet storage (pool) and/or dry storage (concrete canisters), where heat is removed by natural convection. These methods are well understood, technically proven, already in use, and are deemed by industry representatives to be adequate for up to 50 to 100 years.

Several proposals for the long-term management of this highly radioactive waste continue to be examined. In Canada, efforts are focused on the deep disposal of specially packaged HLW in deep caverns in very ancient, essentially non-porous plutonic rocks which show no evidence of movement or fracturing for the last billion years or more. Under this proposal, the aim is to prevent harmful effects on people and the environment by isolating the waste and preventing its migration. To this end, the fuel would be processed into a stable and insoluble

form, put into containers designed to resist degradation by groundwater, surrounded by a buffer to prevent the ingress of groundwater and finally placed in a deep repository designed to prevent migration of radioactive elements to the surface, and yet allow the residual decay heat to be dissipated without altering the integrity of the rock formation. The repository could be filled further to enhance the natural barrier. Advocates of the proposal hold that, in Canada, a single facility would be adequate to store all of the HLW produced in Canada.

Long-term deep disposal is currently the object of intensive research efforts, mainly by AECL at its Whiteshell laboratory and site in Manitoba. Such issues as the behaviour of sealing material, rock stress, water movement and radionuclide migration are being examined to determine their effect on the safety of this waste disposal option. The implementation of any such proposal would require approval by the AECB.

The cost of HLW disposal is not yet fully ascertained and depends on the selection of the site and disposal method. AECL's estimates, based on 10.1 million bundles of used fuel accumulated by the year 2035, and on a disposal schedule over 70 years, range between $9B and $15B. This represents an estimated 1% of household electricity bills from nuclear-generated electricity over the projected period. Most utilities make provision in their electricity rates for accrued fuel disposal costs. For example, as of December 1991, Ontario Hydro had collected $618M for this purpose, and NB Power, over $62M. Although the Committee heard no evidence on the matter, members are aware that a concern exists that the amounts collected by these utilities might not be sufficent to meet the true future costs of disposal. In addition, there is also concern that those funds that have been collected may have already been used for other purposes (existing now only as an account entry) and therefore may not be available for use in future waste management projects.

LLW generated from the operation of nuclear reactors is significantly less radioactive than HLW. Therefore, although that waste must still be controlled, a lower measure of isolation is needed and the disposal methods are technically less complex. Up to now, LLW has been stored in earth trenches, tile holes or concrete bunkers. Long-term options include surface mound burial or disposal in caverns. Large volumes of low-level radioactive waste are produced by the nuclear power industry and the choice of an appropriate disposal site is therefore problematic. It is, both a societal and technical problem. In 1988, a cooperative site search process, under the auspices of the Siting Task Force on Low-Level Radioactive Waste Management, was undertaken to find a storage site. Three Ontario communities have volunteered to go on to the next phase of the process.

According to the Siting Task Force, cost estimates for LLW disposal, including retrieval and restoration of historic waste, transport and the facility vary between $170M and $325M, depending on the disposal option and the site selected.[18]

F. Management of Uranium Mine Tailings

Waste produced by the mining, milling and fabrication of radioactive uranium comes primarily from the milling process, which reduces rock containing uranium and other trace radionuclides to a fine sand and chemically treats it to extract the uranium. The contaminated waste (tailings) contains residual amounts of uranium, thorium and radon.

Although the quantity of waste generated is large (approximately 200 million tonnes so far), the radioactivity of the waste from the milling process is significantly lower than that of reactor waste. Nevertheless, tailings must be stricly controlled to prevent contamination of surface and groundwater and to limit the airborne contamination by radon.

Recently, the AECB has introduced a new policy requiring that all new storage facilities for tailings be sub-surface, and that they be designed and engineered to limit or eliminate interaction with groundwater, even after decommissioning.[19] Facilities built prior to this new policy are monitored, inspected and regulated by the AECB and Environment Canada. The Committee is aware, however, of reports indicating that some existing sites (such as that at Elliott Lake) are cause for considerable environmental concern. Although the Committee was given no evidence of the cost involved in effective long-term management of Canada's uranium mining and processing tailings, it assumes the cost to be substantial.

G. Decommissioning Nuclear Facilities

Decommissioning of nuclear power plants is being actively considered by nuclear electric utilities. Conceptual plans for plant decommissioning and the associated costs have already been investigated for CANDU reactors. All operating Canadian reactors include a component in their electricity costs to cover decommissioning. As of 1991 Ontario Hydro had collected $376M for accrued decommissioning costs. But as was noted in the discussion on page 54 concerning the setting aside of funds, the Committee must question whether or not the money that has been collected is actually available for the stated purpose.

Based on 1984 estimates generated by the Nuclear Energy Agency (NEA) of the Organization for Economic Co-operation and Development (OECD), the discounted cost for immediate decommissioning of a single Darlington-sized unit would be $129M (US); and if decommissioning were delayed by 30 years (as is assumed by Ontario Hydro) it would be $29M (US). Under all reasonable assumptions, the NEA found that the decommissioning cost per unit of electricity produced over the reactor lifetime was less than $0.001 (US) per kilowatt hour.

Finally, all proponents of new nuclear facilities in Canada must develop a decommissioning plan prior to receiving an AECB licence to begin construction of the facility. This plan must include assurance that the finances required to complete decommissioning will be available.

The Committee recognizes that no commercial nuclear power plant anywhere in the world has to date been decommissioned successfully. As a recent OECD study points out, however, a sound base of knowledge on decommissioning techniques and cost has been generated as a result of completed decommissioning projects on research and test reactors. The study authors conclude that one is now able to calculate decommissioning costs with reasonable accuracy.[20]

INDUSTRY'S RESPONSE TO THE ENVIRONMENTAL CHALLENGES

In general terms, the industry views its current environmental practices as appropriate, given what industry representatives consider its high degree of regulation. The AECB has legislated authority to perform an environmental assessment and review on any of the activities on its "automatic referral list", which includes the following:

Authorization to proceed with the siting or construction of:

1. a power reactor for production of electricity;
2. a research reactor of power greater than 30MW thermal;
3. a nuclear-powered vessel;
4. a uranium mining facility not including excavation or ore removal from a site for evaluation and feasibility studies;
5. a radioactive waste disposal facility for irradiated nuclear fuel;
6. a commercial scale uranium/thorium refining or conversion facility;
7. a commercial scale spent fuel reprocessing facility;
8. a commercial scale heavy water production plant using hydrogen sulphide in the process.[21]

The Board also seeks to avoid duplication of effort by accepting the findings of equivalent provincial review processes whenever feasible. Figure 6.1 illustrates the AECB environmental assessment and review process.

In response to the two specific challenges it identified, namely the costs of environmental impact assessments and the new dose limits, the CNA made three recommendations to the Committee.

(1) That all costs incurred by a project due to environmental assessment process be paid for out of government general revenues. Further, areas of overlap between provincial and federal environmental assessment responsibilities should be eliminated.

(2) Instead of meeting the AECB-imposed radiation exposure limit of 20 milli-Sievert per year, the industry should only be required to meet the AECB requirement to calculate radiation exposures to mine workers using a new formula (which requires additional possible sources of radiation exposure to be included). The industry stated it is prepared to begin use immediately of the new formula for calculating radiation exposures.

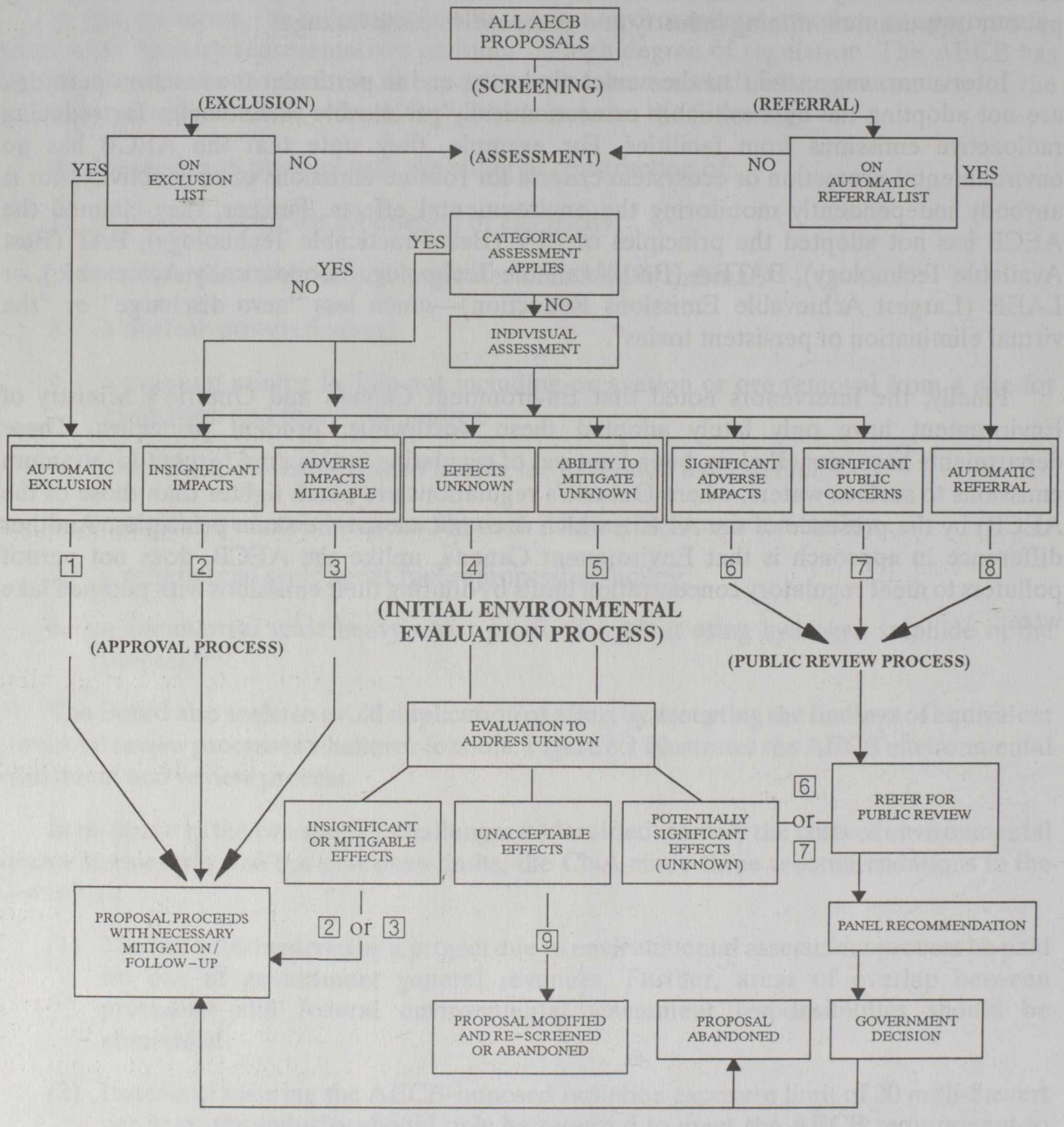
(3) The uranium mining industry be allowed to operate under the ICRP radiation exposure limit of 100 milli-Sievert per five years, rather than the AECB limit of 20 milli-Sievert per year. No timeframe for complying with the AECB 20 milli-Sievert per year exposure limit was given.

The Committee agrees that the AECB should take care not to impose or apply the new ICRP limits in a way that is inconsistent with international practice, and that would needlessly put our own uranium mining industry at a competitive disadvantage.

Intervenors suggested that the nuclear industry, and in particular the reactor operators, are not adopting the best available or economically practicable technologies for reducing radioactive emissions from facilities. For example, they state that the AECB has no environmental-protection or ecosystem criteria for routine emissions of radioactivity, nor is anybody independently monitoring the environmental effects. Further, they claimed the AECB has not adopted the principles of BPT (Best Practicable Technology), BAT (Best Available Technology), BATEA (Best Available Technology Economically Achievable), or LAER (Largest Achievable Emissions Reduction)—much less "zero discharge" or "the virtual elimination of persistent toxins".

Finally, the intervenors noted that Environment Canada and Ontario's Ministry of Environment have only lately adopted these worthwhile, prudent principles. These departments have, nonetheless, been kept out of regulating in this area (except for uranium emissions to surface waters, where Ontario's regulations are much tighter than those of the AECB) by the presence of the AECB, which does not accept the same principles. Another difference in approach is that Environment Canada, unlike the AECB, does not permit polluters to meet regulatory concentration limits by diluting their emissions with pumped lake water.

FIGURE 6.1



Source: Atomic Energy Control Board, Ottawa, Ontario 1990.

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CHAPTER 7

COAL

THE ENVIRONMENTAL CHALLENGES

The coal industry in Canada is no stranger to the challenge of meeting environmental demands. Until quite recently such challenges centred on the mining end of the fuel cycle; namely land reclamation following open-pit mining and water quality, especially acid drainage. These two problems are also faced by other mining operations and the coal industry has been part of the efforts to address them. They have already been dealt with in the section of this report dealing with mining and smelting (Chapter 5).

In more recent times, environmental concerns involving coal have shifted from the production side to the end-use part of the fuel cycle. Atmospheric pollution, particularly SO_2, NO_x and greenhouse gas (GHG) emissions now head the list of environmental challenges. The first two, that is SO_2 and NO_x, are not really new to the coal industry, as both have been subject to regulations and guidelines for a number of years. Such has not been the case for greenhouse gas (GHG) emissions.(1)

The first international initiative to control SO_2 emissions was adopted in Geneva in 1979. At this time Canada became one of the signatories of an agreement to reduce national, and/or transboundary emissions of sulphur oxides by at least 30% by 1993.(2) To meet its obligations under the terms of this agreement, the federal government established the Canadian Acid Rain Control Program, which focused on the seven eastern provinces from Manitoba to Newfoundland. Each province established its own program to meet the Canadian goal of reducing SO_2 emissions from roughly 4.5 million tonnes in 1980 to 2.3 million tonnes by 1994. The smelting and refining industries are the major contributors to the acid rain problem and so have had to make the greatest changes to meet this target. However, electric utilities such as Ontario Hydro, Nova Scotia Power and New Brunswick Power, which use substantial amounts of coal in their generating systems, have also been affected and have set emissions targets, as detailed in Table 7.1. Meeting these emission limits poses a challenge to the part of the coal industry involved in electricity generation.

Of even greater concern to the coal industry, however, is the fact that, under the terms of the Green Plan, the federal government has unilaterally decided to establish a national cap on SO_2 emissions at 3.2 million tonnes annually by the year 2000. Utilities in western Canada, some of which rely heavily on coal-fired generation, are particularly concerned about how this national cap will be apportioned. The Coal Association in its brief to the Committee argued that the low average levels of emissions per unit of land area and the relatively high buffering capacity of many western soils should be taken into account to ensure the avoidance of a situation in which:

> The SO_2 cap will effectively restrict economic growth in certain regions of the country which do not have a problem. Financial resources to address existing environmental problems may be significantly eroded with a stagnant economy. At the same time no identified environmental problem is being solved.(3)

The Committee recommends that (see Chapter 16) the federal government ensure that its implementation of such a national limit takes into account regional differences such as these. The Committee notes with interest the recent announcement by the Alberta government that it will lift the existing restriction on the use of natural gas for the generation of off-peak electricity. It is felt that by shifting to a greater use of natural gas for electricity generation, overall atmospheric emissions can be reduced. The Committee again cautions that, in the absence of a full fuel-cycle analysis, this environmental benefit is not confirmed.

With regard to NO_x emissions, policy development is following a somewhat different route, and one that is appreciated by industry. In this case the initiative once again began with an international protocol. This protocol, signed by Canada in 1988, commits this country to freeze NO_x emissions at 1987 levels, to use the best available technology economically feasible to limit new source NO_x emissions and to establish other appropriate measures for solving NO_x-related problems by 1996.(4) As a first step, the federal and provincial environment ministers set up a Canada-wide consultation program to help formulate a NO_x/VOCs (Volatile Organic Compound) management plan, aimed primarily, but not exclusively, at addressing the problem of ground level ozone. The draft management plan has now been released for discussion. It includes a number of proposals which will affect the electric utilities and hence, the coal industry, again posing some challenges for this sector. A second draft of the plan is scheduled for 1994, which would appear to allow enough time to work out the details.

Measures in the draft plan that will challenge the coal industry, directly or indirectly, include the requirement that utilities use demand-side management in their planning, the establishment of energy efficiency standards for certain electrical equipment (motors, appliances and lighting); the phased introduction of tighter NO_x controls on new power plants across the country; and much more stringent NO_x/VOCs controls on new power plants.(5) The Coal Association appreciates the method being used to develop this plan. It feels that if the measures deal with "real problems," it will be an example of good decision-making. It also notes that, while technologies are available, or are under development to address the problem of NO_x emissions, they will not be cheap.(6) In the end, perhaps cost reduction for new technologies represents the biggest environmental challenge of all.

The issue of greenhouse gas emissions, and the resultant threat of global climate change, is perhaps the most serious environmental challenge facing the coal industry today. The industry suffers from a negative image with regard to CO_2 emissions and is under attack on all sides for its contribution from the burning of coal to generate electricity. The industry would like people to keep this in perspective and have offered the following figures in an attempt to encourage that. The global use of oil, gas and coal combined has been estimated to contribute about 66% of total CO_2 emissions. Of this 66%, coal-fired electricity generation accounts for about one-quarter, or about 16% of total man-made CO_2 emissions. Furthermore, since CO_2 represents only half of all man-made greenhouse gas emissions, the total contribution of the world's coal-fired power stations to the greenhouse effect is about 8%.(7) In producing this CO_2, coal generates approximately 34% of all of the world's electric power.(8)

With abundant supplies of coal in such developing countries as China and India, the use of coal will increase in the decades to come. Meanwhile, the Canadian coal industry advised the Committee it welcomes the challenge of reducing the environmental impact of using coal as much as is economically feasible; it has been, and continues to be, pursuing new technologies in response to this challenge.

TABLE 7.1

UTILITY EMISSIONS TARGETS FOR ACID GAS UNDER THE CANADIAN ACID RAIN PROGRAM	
Ontario Hydro	• From 1986 to 1989, acid gas emissions must not exceed 430,000 tonnes, and of this total, no more than 370,000 tonnes may be sulphur dioxide.
	• From 1990 to 1993, acid gas emissions must not exceed 280,000 tonnes, and of this total, no more than 240,000 tonnes may be sulphur dioxide.
	• In 1994 and subsequent years, Ontario Hydro's acid gas emissions must not exceed 215,000 tonnes, of which no more than 175,000 tonnes may be sulphur dioxide.
Nova Scotia Power Corporation	• Emissions of sulphur dioxide must not exceed 160,000 tonnes per annum by the year 1994.
New Brunswick Power Commission	• Emissions of sulphur dioxide must not exceed 130,000 tonnes per annum by the year 1994.

Sources: (1) Ontario Hydro "Options Available to Meet Acid Gas Limits and Selection of Preferred Options", Toronto; January 31, 1989 (2) Canadian Electr. Assoc., Generation & Research & Development Com; and (3) M. McRae, New Coal Technology and Electric Power Development, Canadian Energy Research Institute, CERI # 38 Apr. 1991, p. 51

INDUSTRY'S RESPONSE TO THE ENVIRONMENTAL CHALLENGES

Looking first at the industry's response to the challenges related to mining, it was previously noted that the coal industry contends that it has responded effectively to the problem of land reclamation. In fact, some companies have come in for high praise from the Alberta Minister of the Environment. He is quoted as saying: "The reclamation programs at Alberta coal mines are absolutely phenomenal. The coal industry set the mine reclamation standard 15 years ago and is the reclamation standard model we are using for all Alberta industries (including oil sands and conventional oil and gas)."[9] In addition, on the mining side, the industry is using large scale mining equipment and unit trains which make more efficient use of fuel and there by reduce atmospheric emissions.[10] Productivity at the mines has also been increased, which, in many instances, has further reduced the environmental impact per unit output.

In responding to the various challenges from atmospheric pollutants, the coal industry has made a great deal of progress and a wide variety of new technologies are available and/or being developed or put into use. For example, the three utilities mentioned in the above section of this report are taking steps to meet the challenges outlined in Table 7.1. Ontario Hydro is planning to retrofit flue gas desulphurization (FGD) scrubbers on two 500 megawatt coal-fired units at Lambton generating station by 1994, and may need to add the same equipment to other similar units in order to meet the longer term targets. The final number will depend on the growth in demand for electricity in the province, among other factors. Growth in demand in turn depends on the success of the utility's demand management and conservation programs. Other long-term options for reducing acid gas emissions include further reliance on nuclear energy, the array of new, renewable energy sources, small-scale hydro sources, cogeneration, purchases from out of province and such clean coal technologies as IGCC (Integrated Gasification Combined Cycle) plants.(11)

In the Maritime Provinces, New Brunswick Power is counting on coal for much of its future development and, as a start, will be including FGD technology on the coal-fired Belledune plant to be in operation in 1994. To meet the provincial SO_2 limits some existing coal-fired plants will be converted to burn low-sulphur coal and others will be retrofitted with FGD scrubbers. Like Ontario Hydro, New Brunswick Power is looking at the possibilities in IGCC technology. Nova Scotia Power has adopted a different technology to meet its future emission reduction targets; Canada's first commercial fluidized-bed combustion (FBC) unit is being constructed at Point Aconi. This unit will allow for a 90% sulphur recovery rate. Other options being examined or introduced include limestone injection, IGCC, FGD retrofits and the burning of more low-sulphur coal.(12) Many of these approaches to reducing SO_2 emissions will also result in lower levels of NO_x being produced and emitted. In addition, selective catalytic reduction offers an effective, if expensive, means of reducing NO_x emissions. It should be noted, however, that none of these options will be particularly helpful in reducing CO_2 emissions. In fact, the energy required to operate some of the systems may increase CO_2 emissions.

In terms of CO_2 reductions, it is well accepted that "The most practical and economic method known today for reducing CO_2 emissions from coal is to increase the energy efficiency of coal utilization technologies."(13) As an example, it has been shown that for each percentage point increase in absolute power generating efficiency, there is a resultant decrease in CO_2 emissions of 3 to 4%.(14) There is no doubt that using coal to generate electricity has already shown a great improvement in efficiency. In the early years of this century, for example, the average efficiency of coal-fired generating systems was just 8%. Today, in most developed countries state-of-the-art coal-fired generation systems typically operate at some 37% efficiency. Table 7.2 outlines the efficiencies expected from a number of new technologies compared to existing base-cases, along with an estimate of the resultant CO_2 savings which they are expected to deliver.

TABLE 7.2

Comparison of Energy Efficiency and the CO_2 Reduction Potential for Various Coal-Fired Power Generation Technologies

Base Case	Avg. Low 25 / Avg. High 33 %	Potential reduction in CO_2 emission from base (%)	
EXISTING THERMAL POWER PLANTS	**ENERGY EFFICIENCY**	**FROM LOW BASE**	**FROM HIGH BASE**
COMMERCIALLY ADVANCED:			
PULVERIZED COAL(PC)	37	31	9
ATMOSP. FLUID. BED COMBUS. (AFBC)	37	31	9
CO-GENERATION:			
COMBINED HEAT & POWER (CHP)	81	69	59
IMMINENT:			
PRESS. FLUID. BED COMBUS. (PFBC)	40	36	16
INTEGR. GAS. COMB. (IGCC)	42	39	20
HYBRID IGCC/FBC	46	45	27
DEVELOPING:			
IGCC/FUEL CELLS	50	49	33
MAGNETOHYDRODYNAMICS (MHD)	55	55	40

Source: (1) M. McRae, "New Coal Technology & Electric Power Development", CERI, #38, Apr. 1991 in IEA, "Potential to Reduce Carbon Dioxide Emissions", Technical Report, Paris, France: IEA, 1991, p. 33; (2) I.M. Smith & K.V. Thambimuthu, "Greenhouse Gases, Abatement & Control: The Role of Coal", London, U.K.: IEA, 1991

For purposes of comparison, Tables 7.3.1 to 7.3.3 are also presented. These very useful tables were given to the Committee by the Coal Association of Canada during its presentation. They are part of a compilation which that organization prepared for the Department of Energy, Mines and Resources early in 1991. Though some of the estimates are based on very early data, they put together in one document the estimated costs of these technologies, along with their expected benefits.

The three technologies with the greatest near-term potential for reducing CO_2 from thermal power plants are advanced pulverized coal (PC) boilers, fluidized-bed combustion (FBC) and integrated gasification combined cycle (IGCC) technology. Commercially available PC technology operates at about 37% efficiency, as already noted. Work is underway to develop ultra-supercritical PC boilers and turbines, through the introduction of new materials and construction methods. Efficiencies of the order of 45% are expected.(15)

In FBC technology, in place of the conventional furnace, coal and limestone are "fluidized" by a rising stream of air. Unburnt coal and ash are returned to the furnace for further burning and the SO_2 derived from the coal reacts with the limestone, greatly reducing SO_2 emissions. The lower combustion temperatures of the process lead to less formation, and hence emission, of NO_x.(16) Efficiencies of new FBC plants can be improved to about 40% when the system is operated under high pressure. Such PFBC systems are under construction or planned in the United States, Europe and Japan.(17)

Despite all the advantages of FBC technologies, their achievements may soon be surpassed by IGCC technology. Gasification of coal is a well established technology in which hot coal reacts with oxygen and steam to form a synthesis gas. Current research is aimed at increasing the yield from this process and making it as environmentally benign as possible. The gas produced is cooled, cleaned and used to fire a gas turbine. Waste heat from each step—the gasification, gas cooling and turbine exhaust—is then used to produce steam to power a conventional turbine. This integrated system can achieve efficiencies of better than 45% for electricity generation alone and up to 80% for combined heat and power. The world's first large-scale demonstration plant, a 250 megawatt unit, is under construction in the Netherlands and will be in operation in 1993. Germany will have a 300 MW unit on-line in 1995. In Canada, a joint IGCC demonstration project involving the coal industry, the federal government and the governments of British Columbia, Alberta and Saskatchewan was begun in 1990. The first step is a $1 million feasibility study, and, if all goes well, a demonstration plant could be in operation in Canada by 1996. Such technologies indicate the response of the coal industry around the world to environmental challenges while ensuring that coal continues to contribute a vital share of the world's energy production.

TABLE 7.3.1

Technologies Which Are Currently In Use

TECHNOLOGY	REDUCTION IN EMISSIONS	POTENTIAL COSTS / BARRIERS
Conventional Pulverized Coal	– Base Case	– Capital Cost $1100/KW-$1700/KW, 2-8 cents/kWh – Operating Cost 2-8 cents/kWh
Blending	– No change in CO_2 – 40-45% reduction in SO_2 – No change in NO_x – Pulverized coal as base	– Performance dependent on available coal – Performance dependent on available boiler technology – Will use FBC or IGCC technology
Atmospheric Fluidized Bed Combustion (AFBC)	– Slight increase in CO_2 – 85-90% reduction in SO_2 – 40-50% reduction in NO_x – Pulverized coal as base	– Higher costs (20-39% above base capital costs) – Operating costs – Cost of power over life
Combined Heat & Power (CHP)	– 54% reduction in CO_2 – Pulverized coal as base	– Institutional barriers – Needs co-operation between different segments of society
Flue Gas Desulphurization (FGD)	– 0-12% increase in CO_2 – Up to 95% reduction in SO_2 – No change in NO_x – Pulverized coal as base	– Electric generation costs are increased by 20-30% – Capital cost increase of $200-$300/KW – Feasible control devices exist for certain emissions (e.g. SO_2) but not for others (e.g. CO_2) – A different solid form of waste is produced, requires disposal – Plant efficiency is often reduced – Needs more work on cost reduction

Source : Adapted from Coal Association of Canada, Letter to Bruce Howe, Deputy Minister of Energy, Mines and Resources, January 1991, p. 1–7

TABLE 7.3.2

Technologies Which Could Be Implemented Within 10 Years

TECHNOLOGY	EMISSIONS REDUCTION	POTENTIAL COSTS / BARRIERS
Conventional Pulverized Coal	– Base	
Advanced Coal Cleaning	– No change in CO_2 – 30–90 % reduction in SO_2 – No change in NO_x – Pulverized coal as base	– Dependent on coal properties, generally only applicable to higher sulphur coals – Needs additional research
Selective Agglomeration & Advanced Froth Flotation	– No change in CO_2 – 50–70% reduction in SO_2 – No change in NO_x – Pulverized coal as base	– Dependent on coal properties – Needs additional research
Low NO_X/SO_X Burner	– No change in CO_2 – 90+% reduction in SO_2 – 50–60% reduction in NO_x – Pulverized coal as base	– Limited operational experience – Requires further development and demonstration
Pressurized Fluidized Bed Combustion (PFBC)	– 7–16% reduction in CO_2 – 90–99% reduction in SO_2 – 0–70% reduction in NO_x – Pulverized coal as base	– Cost increase due to major repowering of existing plants – Additional wastes are created – Requires additional development and demonstration
Integrated Gasification Combined Cycle (IGCC)	– 5–10% reduction in CO_2 – 95–99% reduction in SO_2 – 70% reduction in NO_x – Pulverized coal as base	– Limited experience – Requires additional development and demonstration
Sorbent Injection (during combustion cycle)	– Slight increase in CO_2 – 50% reduction in SO_2 – Some reduction in NO_x – Pulverized coal as base	– Limited performance with low sulphur coal – Requires further development and demonstration
Coal Fired with Fuel Gas Desulphurization & Selective Catalytic Reduction	– No change in CO_2 – 20–90% reduction in SO_2 – 90% reduction in NO_x – Pulverized coal in base	– No experience with North American coals in catalytic reduction – Needs more development and demonstration
Sorbent Injection Lifac (during post combustion cycle)	– No change in CO_2 – 80% reduction in SO_2 – Pulverized coal as base	– Lack of full size demonstration – Requires additional development and demonstration
Duct Injection	– No change in CO_2 – 50–70% reduction in SO_2	– Lack of full size demonstration – Requires further development and demonstration
Convert Coal Fired Generating Plants to Natural Gas	– 20–50% reduction of CO_2	– Rising natural gas prices – Uncertainty on future costs. What do you do when it runs out? – Estimated reserve base of natural gas is only a few decades even at today's demand levels – Production and distribution of natural gas add methane and CO_2 to the atmosphere through leakage
Injection of CO_2 into Depleted Natural Gas Reservoirs	– Represents a significant fraction of the total coal–fired power plant emissions	– Cost? – Capacity of reservoirs to hold CO_2 – Geographic limitations – Requires additional study

Source : Adapted from Coal Association of Canada, Letter to Bruce Howe, Deputy Minister of Energy, Mines and Resources, January 1991, p. 1–7

TABLE 7.3.3

Technologies Which Could Be Implemented Beyond 15 Years

TECHNOLOGY	REDUCTION IN EMISSIONS	POTENTIAL COSTS / BARRIERS
Conventional Pulverized Coal	– Base	
Advanced IGCC	– 12–21% reduction in CO_2 – 95–99% reduction in SO_2 – 90% reduction in NO_x – Pulverized coal as base	– Research required in advanced gas turbines
IGCC Fuel cells	– 40% reduction in CO_2 – 99+% reduction in SO_2 – 100% reduction in NO_x – Pulverized coal as base	– Demonstration of molten carbonate or solid oxide fuel cells required
Topping cycle	– 51% reduction in CO_2 – 99+% reduction in SO_2 – 90% reduction in NO_x – Pulverized coal as base	– In very early stages of development – Additional research needed
Magnetohydrodynamics	– 87% reduction in CO_2 – Pulverized coal as base	– In very early stages of development – Additional research needed

Source : Adapted from Coal Association of Canada, Letter to Bruce Howe, Deputy Minister of Energy, Mines and Resources, January 1991, p. 1–7

ENDNOTES

(1) Coal Association of Canada, "Canadian Environmental Challenges: A Perspective by the Coal Association of Canada," Brief Presented to the House of Commons Standing Committee on Energy, Mines and Resources, Ottawa 1991, p. 6.

(2) K. Morgan McRae, New Coal Technology and Electric Power Development, Canadian Energy Research Institute Study #38, April 1991, p. 45.

(3) Coal Association of Canada (1991a), p. 7.

(4) McRae (1991) p. 46.

(5) *Ibid.*

(6) Coal Association of Canada (1991a), p. 7.

(7) World Coal Institute, Coal: Solid Foundation for the World's Electricity, London, England, 1991, p. 11.

(8) K.M. Sullivan, The Effects of CO_2 Emissions from Coal Fired Power Plants, World Coal Institute, 1991, p. 8.

(9) S. Salaff, "The Copobianco Forecast," Canadian Mining Journal, October 1991, p. 59.

(10) Coal Association of Canada, Letter to Bruce Howe, Deputy Minister of Energy, Mines and Resources, 18 January 1991b, p. 4.

(11) McRae (1991), p. 52.

(12) *Ibid.*

(13) International Energy Agency, Global Climate Change Policy: Potential to Reduce Carbon Dioxide Emissions, Paris, 1991, p. 17.

(14 *Ibid.*

(15) *Ibid.*

(16) Royal Dutch/Shell, Coal And The Environment, SBS #1, 1991, p. 6.

(17) International Energy Agency (1991), p. 19.

CHAPTER 8

OIL

THE ENVIRONMENTAL CHALLENGES

The oil industry shares many of the environmental challenges that have been identified for the coal industry, and will be mentioned for the upstream part of the natural gas industry. The industry representatives who appeared before the Committee outlined these challenges for us clearly and succinctly. It should be noted that the industry is usually thought of as two separate "industries," one being the "upstream" or exploration, production and distribution sector and the other the "downstream" operations, which include refining and end-use applications. In fact, it is more common in the business to discuss the upstream oil and gas industry together, with the downstream sectors seen as a separate entity, rather than to look at the oil and gas concerns separately, since most oil producers in Canada are also gas producers. For this reason, much of the discussion in this chapter refers to environmental challenges that are common to both the oil and gas industry.

The membership of the Canadian Petroleum Association (CPA) and the Independent Petroleum Association of Canada (IPAC) included most of the medium to larger players in the upstream oil and gas industry in Canada. In the fall of 1992 these two associations merged to form the Canadian Association of Petroleum Producers (CAPP). Because they appeared before the Committee prior to the merger they are referred to in this report by their original titles. In submissions to the Committee, representatives outlined the environmental issues affecting their sector.[1, 2] First is the issue of emissions of CO_2 and other greenhouse gases. CO_2 emissions from the upstream oil and gas industry are primarily due to the combustion of gas as fuel in the industry and also from activities related to electricity use. A small but growing amount is from the CO_2 contained in raw gas. (Natural gas, as it comes from the ground contains some CO_2, which is released during processing.) According to forecasts from Alberta it is anticipated that CO_2 emissions from oil and gas industry activities could increase by as much as 22% from 1988 levels by the year 2000.[3] If this forecast is accurate, it poses a major problem as Canada strives to reach the CO_2 stabilization target by 2000.

Both organizations are also concerned that there is too much scientific uncertainty about the link between carbon dioxide emissions and global warming. In view of this uncertainty they feel that it is not possible to establish feasible or effective emission targets, and are critical of the federal government's commitment to stabilize Canada's CO_2 emissions at 1990 levels by the year 2000.[4, 5] They also strongly believe that such targets should not be set without extensive consultation with all those affected. Although the Committee is strongly sympathetic to the latter point, it is convinced there is sufficiently compelling evidence that changes in the global atmosphere can result in significant global climate change, to warrant action.

Emissions of SO_2 are of concern to members of the industry; they do not agree with the proposed national cap (see Chapter 7 for a discussion of Canadian targets). Like spokesmen for the coal industry, representatives of the upstream oil and gas industry told the Committee

that they do not accept that SO_2 emissions are a problem in Western Canada and so do not want to see limits set for the producing provinces. They argued that costs of meeting such limits could be high and the benefits minimal. Most of the SO_2 comes from the production of "sour" gas, which is simply gas containing hydrogen sulphide (H_2S). The industry uses state-of-the-art technology to capture sulphur emissions and rates of capture generally exceed 95%. The industry representatives said that the remaining H_2S is combusted and released as SO_2, at rates which do not exceed ambient air standards or deposition targets for soil.(6) Even with the large volumes of gas produced in western Canada, the upstream petroleum industry accounts for just 11% of Canada's total SO_2 emissions.

The downstream sector of the oil industry is also facing challenges relating to SO_2 emissions, with new restrictions expected on the level of sulphur in diesel fuels and heavy fuel oil. The Canadian Petroleum Products Institute (CPPI) has estimated that to meet these two objectives refineries would have to spend from $750 million to $1 billion for diesel fuels and from $650 to $950 million for heavy fuel oil.(7) As recent events, including refinery and service station closings, have shown, the downstream petroleum industry is not in a financial position, given the current regulatory and pricing regime, to undertake the potentially costly technological changes required to move quickly towards these environmental goals. Closing refineries will, of course, result in lower emissions, but we are certain that no one would suggest that this is a preferred means of reaching Canada's emission targets.

The oil industry will be faced with the challenge of meeting the NO_x/VOCs emission limits proposed in the draft NO_x/VOCs Management Plan. These emissions are the main cause of ground-level ozone, which occurs mainly in large urban areas and results primarily from burning fossil fuels in motor vehicles and in industrial processes. The plan is discussed in more detail in Chapter 7. Because ground-level ozone is primarily an end-use problem, it will have a greater impact on the downstream sector of the industry. The CPPI has estimated that meeting the proposed mid-1990s targets at refineries could cost its members as much as $600 million.(8) The upstream sector of the industry is concerned because, even though most of its operations are far from urban centres and far from each other, the management plan will require use of low-NO_x, natural-gas fired engines at new installations. The industry feels that reducing emissions will not have a significant impact on theareas in which ozone pollution is most severe and so would be neither cost effective nor environmentally effective.(9)

The upstream oil and gas industry faces a number of additional environmental challenges unrelated to atmospheric emissions. For example, it must deal with waste management. The waste products of particular concern are produced water, drilling wastes, and production wastes. None of these wastes is classified as hazardous under the Canadian Environmental Protection Act, but they can pose a threat to the environment if not properly handled. The industry must ensure that they are properly handled to protect both the environment and human health.(10)

Both the upstream and downstream parts of the industry are also concerned with the potential for spills of oil or of salt water (brine). Most spills are small, but there is always the danger of large spills, which could cause extensive environmental damage. The industry faces the challenges of preventing spills, developing new technologies and methods of spill prevention, developing new spill clean-up techniques, organizing effective spill response capabilities and finally, of communicating with the public on this issue.(11)

The reclamation of land disturbed by upstream operations including drilling, seismic work, and pipeline and facility construction presents yet another environmental problem to the industry.[12] The restoration of abandoned oil and gas well sites to their original state above and below ground is part of this problem, and one which is becoming more pressing. Especially in the Arctic, severe environmental damage can result from improper or inadequate shut-down, clean-up and restoration of abandoned wells. There are some 90,000 well sites in Alberta alone and the industry estimates that they will cost an average of $50,000 each to clean up once they are abandoned.

As the Western Sedimentary Basin matures as an oil production area, the pace of abandonment will increase. At the moment some 30,000 wells have stopped producing. Of this total only 4,000 have been declared abandoned, and so must, by law, be cleaned up. In order to ensure that companies fulfil their obligations in this respect, later in 1992 Alberta is expected to pass legislation to speed up the rate at which non-producing wells must be declared abandoned. In addition, the legislation proposes to impose a fee on owners of inactive wells, with the money going into a special fund for environmental reclamation.[13] This new legislation poses more of a financial challenge than a technological one for an industry that is not, in the current regulatory and pricing climate, performing well financially. The downstream sector also must reclaim sites where industrial facilities have ceased production, and when gasoline service stations are taken out of use. As the twelve to fifteen thousand service stations still in operation move to replace old metal holding tanks with fibre glass tanks, over the next five years or so, the cost could reach $1 to $2 billion.[14]

In terms of the downstream petroleum sector, refiners will soon have to finance the technological changes associated with producing reformulated gasoline. The CPPI has estimated that the investment required to reduce the amount of benzene and other aromatic hydrocarbons in gasoline could be as high as $700-$850 million. It further pointed out to the Committee that these reductions will be complicated by the fact that already 15% of refinery feedstock is Canadian synthetic crude oil derived from the oil sands, a source which has a relatively high aromatic content. The CPPI sees the installation of additional measures to reduce toxics and other potentially harmful substances as costing another $2.5 to $3 billion.

Both parts of the petroleum industry noted that there would be additional costs in meeting increasingly stringent water quality standards in the various provinces in which they operate. The CPPI cited the upcoming changes to Ontario's MISA (Municipal Industrial Strategy for Abatement) water quality standards as an example.

INDUSTRY'S RESPONSE TO THE ENVIRONMENTAL CHALLENGES

All three of the representatives of the industry who made presentations to the Committee (CPA, IPAC and CPPI) have been involved for many years in helping their members respond to environmental challenges. For example, the CPA first formed an environmental standing committee in the early 1970s and was a charter member of the Alberta Petroleum Industry/Government Environmental Committee (1973).[15] In the 1970s, CPA's environmental efforts were largely related to oil and brine spills, but they are now involved in much more broadly based research efforts. In fact, they are now associated with more than 50

research projects worth about $300 million and involving industry, other associations such as IPAC, governments, universities and other countries. One of the largest initiatives is the Task Force on Oil Spill Preparedness, under the terms of which $5.5 million will be spent over five years. This Task Force, of which IPAC is also a member, was responsible for preparing a major study on the ability of the upstream sector to respond to oil spills.(16) Unfortunately, the study found the industry to be ill-prepared to deal with offshore spills in certain regions or situations (i.e., Hibernia) and made a host of recommendations as to how this might be rectified. Many of the recommendations of the Task Force are now being implemented. In general, however, the report found that the Canadian oil industry's preparedness for spill response compares favourably with the best in the world.

Drilling in the Canadian offshore regions is a challenging undertaking and the problems and solutions associated with oil spills in such an environment are unique. In 1980, the upstream industry established COOSRA (Canadian Offshore Oilspill Research Association), which is funded at the level of about $1 million per year by companies involved in offshore drilling. COOSRA has carried out a number of studies including the 4-year, $7 million Baffin Island Oilspill Study, which involved governments as well as private industry in Canada and Norway.(17)

With respect to the challenge posed by SO_2 emissions, the upstream industry established the ADRP (Acid Deposition Research Project) in 1983. This five year, $11 million study was designed to provide baseline data on the impact of SO_2 emissions and other air pollutants. The study concluded that, given the alkaline nature of prairie soils and the distribution of facilities, western Canada does not have an acid deposition problem, although the study noted that the situation in Northern Alberta is different.(18) It is on the basis of these conclusions that the industry opposes the federal decision to establish a national SO_2 emission target, with specific regional targets for the west.

Oil and gas industry representatives have also, with virtual unanimity, voiced their opposition to the federal government's unilateral decision to adopt as a national goal the stabilization of CO_2 at 1990 levels by the year 2000. They do not believe that we have sufficient understanding of the environmental, social and economic consequences of such commitments. As discussed elsewhere in this report, they recommend that Canada establish a multi-stakeholder consultative process to ensure that all factors are considered before committing the country to a course of action. In the meantime, however, the industry does believe that every effort should be made to reduce greenhouse gas emissions through the implementation of those technologies or operations that make economic sense in their own right.

In fact, the CPA's CO_2 Control Options Task Group has recently completed a detailed study of the potential within the upstream sector to reduce CO_2 emissions economically.(19) The study concluded that between 6 and 7% of current oil- and gas-related CO_2 emissions could be eliminated by conservation measures that are currently available and economically attractive. A capital investment of $54 million (in 1991 dollars) would be required. As pointed out in the study, the projected 6 to 7% savings contrasts dramatically with the theoretical potential of 31% estimated by the Alberta Department of Energy in 1990. Measures currently deemed attractive to the industry include thermal projects, mostly in the sour gas processing facilities, and reductions in electricity use throughout the upstream sector.

Cogeneration of electricity, for sale to the utilities, and of heat for gas processing or in-situ bitumen production is not now considered economic. The main reason is the low price that utilities are currently willing to pay for the electricity. If and when economics allows its introduction, cogeneration at oil and gas facilities could result in major reductions in the CO_2 emissions from coal-based power stations in Alberta.(20)

As environmental regulations governing the industry have grown, so too have the efforts of industry to meet them. Like other highly regulated energy supply industries, the oil and gas sectors have always responded to new environmental initiatives; meeting these requirements is simply the way of doing business. A complex web of environmental legislation and regulations has grown up federally and provincially over the years to the point where, in the industry's view, they are sometimes duplicated at the various levels of government, and at times are even contradictory. The industry would clearly like to see a rationalization of environmental legislation to avoid these problems. It is also calling on the federal government to priorize its environmental agenda. The industry feels unable to respond adequately to the challenges of the Green Plan without some indication from government of its priorities among the 309 proposals.(21)

In an effort to guide their members through the maze of environmental regulations, industry associations have prepared manuals outlining the regulatory hurdles faced by each part of the industry. For example, the CPA spent three years compiling a massive compendium of legal, regulatory and technical requirements for environmentally sound oil field practices. The first issue of "Environmental Guidelines for the Petroleum Industry" was released in 1980. CPPI has also developed guidelines for member companies in the downstream sector in such areas as emergency response, waste management, environmental audits and storage tank systems.(22)

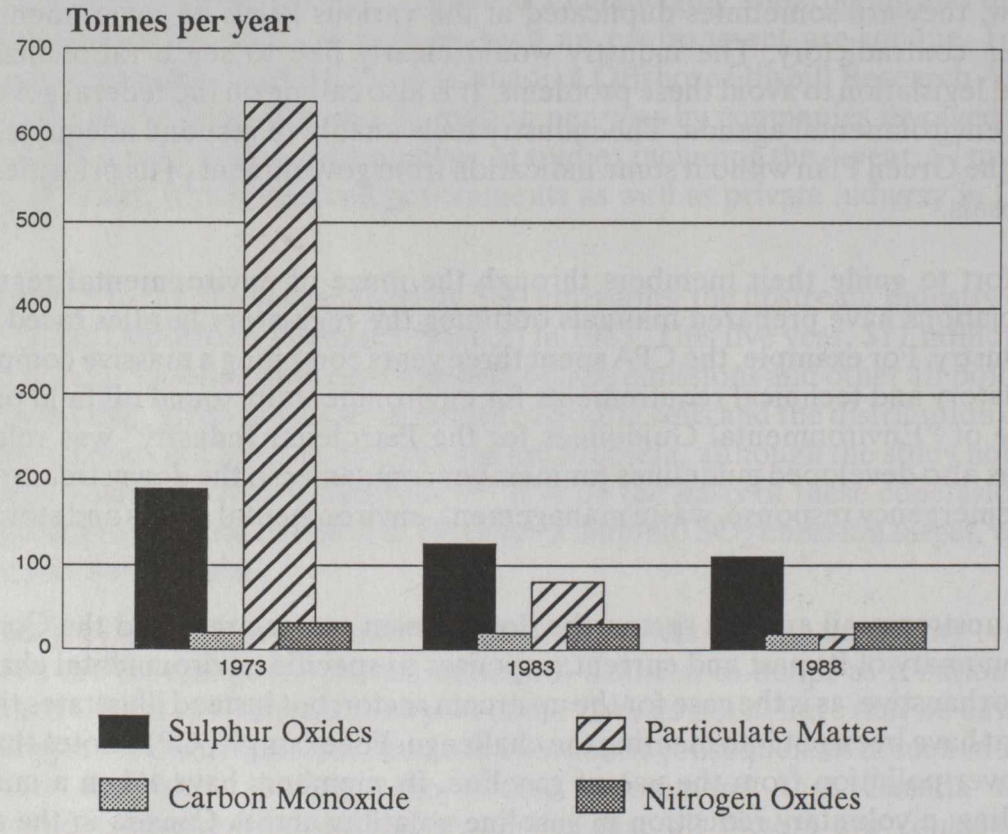
Like the upstream oil and gas sector, the downstream sector presented the Committee with a good summary of its past and current responses to specific environmental challenges. The list is not exhaustive, as is the case for the upstream sector, but instead illustrates the effort and money that have been put into meeting the challenge. For example, CPPI notes that, given the concern over pollution from the use of gasoline, its members have taken a number of actions including: a voluntary reduction in gasoline volatility across Canada in the summer months, at an increased annual operating cost of about $30 million; the installation, in advance of proposed regulations, of vapour recovery systems to capture and recycle vapours during bulk gasoline transfers in high ozone areas such as the Lower Fraser Valley of B.C. and the Quebec-Windsor Corridor; and the phase out of leaded gasoline ahead of the regulated schedule.

CPPI members have been working at improving the energy efficiency of their refinery operations and at constantly upgrading environmental technologies and processes. Figure 8.1 clearly illustrates the progress they have made in curtailing atmospheric emissions. Energy efficiency at oil refineries has improved by approximately 30% in the last decade and further savings are possible, although at higher cost. Compared to the cost of environmental achievements in the industry over the last 20 years, the cost of meeting current environmental challenges is, according to industry, staggering. CPPI has made a rough estimate that this will require a financial commitment in the order of $7.5 to $10 billion.(23) It notes that if only $6

billion were to be spent, it would represent 40% of all the industry's investment. If absorbed by the industry and not passed on to consumers, this would be equivalent to 35-50% of the downstream industry cash-flow, restricting the amount left to pay wages, dividends, profits and taxes. These figures do not include increased environmental costs which would be borne by the industry's suppliers and customers. Some estimate this additional cost at $18 billion. It should also be noted, however, that these findings deal only with the costs, and not the potential benefits which could result from increased productivity and improved competitive position.

FIGURE 8.1

Air Emission Reductions at Refining and Marketing Sites



Source : As quoted in Canadian Petroleum Products Institute, *Environmental Challenges: A Perspective from the Canadian Petroleum Products Institute,* Brief to the House of Commons Standing Committee on Energy, Mines and Resources, December 1991, Appendix X.

In answering the Committee's questions on realistic responses to the environmental challenges, the oil and gas industries stressed that their current financial situation does not permit them to incur additional expenses. The CPA put the situation in the following words:

> Although governments and the public play a major role in directing economic growth and environmental protection, the costs of achieving sustainable development are drawn mainly from revenues generated by Canada's industries.
>
> To continue generating these revenues, Canada's industries must be economically healthy and competitive in the world market place.(24)

The Committee understands this point of view and hopes that our recommendations will help make it possible to achieve truly sustainable mineral and energy development.

ENDNOTES

(1) Canadian Petroleum Association (CPA), The Canadian Petroleum Association's Response to Current and Future Environmental Challenges, Submission to the House of Commons Standing Committee on Energy, Mines and Resources, October 1991a.

(2) Independent Petroleum Association of Canada (IPAC), Submission to the House of Commons Standing Committee on Energy, Mines and Resources, 26 September 1991.

(3) Canadian Petroleum Association, CO_2 Reduction Through Energy Conservation, May 1991b, p. 1.

(4) Canadian Petroleum Association, Response to Environment Canada's "Framework for Discussion on the Environment": A Summary of Issues for Input into "The Green Plan: A National Challenge," June 1990a, p. 62.

(5) IPAC (1991), p. 19-20.

(6) CPA (1991a), p. 19.

(7) Canadian Petroleum Products Institute (CPPI), "Environmental Challenges: A Perspective from the CPPI", Brief presented to the House of Commons Standing Committee on Energy, Mines and Resources, December 1991, p. 17-18.

(8) *Ibid*.

(9) CPA (1991a), p. 22.

(10) *Ibid*, p. 24.

(11) *Ibid*, p. 25-26.

(12) *Ibid*, p. 27.

(13) "Oilpatch Tallies Cleanup," *Globe and Mail* (Toronto), 20 January 1992, p. B6.

(14) CPPI (1991), p. 18.

(15) CPA (1991a), p. 85.

(16) Canadian Petroleum Association and Independent Petroleum Association, Oil Spill Preparedness in the Upstream Petroleum Industry, November 1990b.

(17) *Ibid*, p. 86.

(18) CPA (1990a), p. 69.

(19) CPA (1991b), 45 p.

(20) *Ibid*, p. 4.

(21) Ian Smyth, President, CPA, *Minutes of Proceedings and Evidence*, House of Commons Standing Committee on Energy, Mines and Resources, 20 November 1991, Issue #7, p. 7:41.

(22) CPPI (1991), p. 12.

(23) *Ibid*, p. 16.

(24) CPA (1991a), p. 6.

CHAPTER 9

NATURAL GAS

THE ENVIRONMENTAL CHALLENGES

As already noted, in the upstream or production end of the business it is difficult to separate the oil and the gas sectors. As a result, the environmental challenges facing the upstream natural gas industry were covered in the chapter on oil (Chapter 8) and readers are referred there for details. Concerns in the upstream sector that were expressed only by the natural gas industry representatives will be discussed here, but by and large this chapter deals with the downstream or end-use part of the natural gas industry.

The Committee heard from the Canadian Gas Processors Suppliers Association that, along with the rest of the fossil fuel industries, gas producers face problems as Canada tries to stabilize CO_2 emissions at 1990 levels by the year 2000. The gas processing industry will address this issue at facilities involved in gas-sweetening, in hydrogen and methanol plants and in power stations.(1) The natural gas representatives who appeared before the Committee caution against setting CO_2 reduction limits on a per fuel basis. In other words, it believes that, because of the environmental advantages of gas over other fossil fuels, its use will increase dramatically in the coming years. However, as production increases, so too will the relative contribution of natural gas to our overall CO_2 emissions. Restricting the amount of CO_2 that natural gas can contribute could, therefore, conceivably slow the rate at which it was substituted for other, more damaging, fossil fuels. This would clearly work against achieving the desired reductions and must be taken into account when designing policies.

The advantage of natural gas in reducing CO_2 emissions at point of use is evident. CO_2 is produced by the combustion of all fossil fuels, and accounts for about 50% of total greenhouse gas emissions. Not all fossil fuels, however, produce the same amount of CO_2 in the combustion process. Natural gas, because of its higher hydrogen to carbon ratio, produces the lowest level (about 49.4 tonnes per terajoule in industrial end-use applications). Coal emissions produce an estimated 79% more than gas; heavy fuel oil 65% more and gasoline 37% more.(2)

Clearly, at the point of end-use, natural gas is preferable to other fossil fuels in terms of its CO_2 emissions. The same can be said in terms of its SO_2 emissions in end-use applications, since processed natural gas contains no significant quantities of sulphur. Well-head gas, however, often does contain sulphur—it is then called sour gas—and must be removed during processing. It is at this processing stage that SO_2, along with some CO_2 and methane, may be released to the atmosphere. Current processing plants successfully remove about 95% of the sulphur, in the form of hydrogen sulphide, while the remainder is flared off, resulting in SO_2 release. In the case of such emissions, the natural gas industry is concerned that as the

production of natural gas increases, so too will SO_2 emissions. The Committee was told that "The cap designed to reduce or limit SO_2 emissions must not be applied so as to render production of natural gas uneconomic. As indicated earlier, stabilization targets cannot be applied on a single sector basis . . ."(3)

The problem of methane leakage also confronts the natural gas industry. Industry officials told the Committee that this problem is well in hand. It is often pointed out that methane is as much as 30 times more effective as a greenhouse gas than CO_2, and accounts for some 20% of the impact of all greenhouse gas emissions worldwide. However, the natural gas industry is quick to point out that, of this total, natural gas leakage accounts for less than 2%. Global releases of methane come overwhelmingly from marshes, paddy fields and enteric fermentation in animals (animal belches and farts).(4) The industry also points to a 1989 British study in which 41 natural gas operating companies around the world were surveyed to determine the rate of methane leakage. The study concluded that, on a worldwide basis, the throughput leakage factor was just 0.63%.(5) The Canadian Gas Association (CGA) has carried out its own study and has estimated that in Canada the leakage rate is lower still, at about 0.3%-0.5%, with the better performance attributed to the facts that our facilities and systems are generally newer than average and our standards are already among the highest in the world.(6) It should be borne in mind, however, that in spite of the natural gas industry's relatively low contribution to greenhouse gas emissions, through methane leakage, its full-cycle contribution relative to all other anthropogenic sources is still significant.

The natural gas industry, unlike other fossil fuel industries, looks on the concern about ground-level ozone as both a challenge and an opportunity. The opportunity arises from the reduced levels of ozone precursors emitted by natural-gas powered vehicles. Under the proposed terms of the NO_x/VOCs Management Plan, emissions of these substances will have to be reduced significantly in the two priority areas of the Lower Fraser Valley in B.C. and the Windsor-Quebec City Corridor. This could provide a good market for compressed natural gas (CNG) vehicles.

Another challenge facing the gas industry involves NO_x emissions from gas turbines used to move gas through the pipeline system. The CGA is participating in discussions with the federal government as details of the management plan are worked out. Its concern is over proposals that would see major changes to emission standards affecting these turbines, even though most of them do not lie within the two priority areas. The CGA is worried about the impact of these changes on the cost of delivering gas to consumers. Also of concern is the development of tougher NO_x standards for natural gas-burning equipment, particularly equipment used in industrial processes in the priority air sheds.(7)

The natural gas industry faces its share of environmental challenges, even though it does appear to have inherent advantages over other fossil sources in some key areas. The Committee is aware that, at the point of end-use, there are advantages. We were also interested, however, in understanding the environmental impacts of the full fuel cycle, from exploration, through production to end-use, of the various energy sources available to Canadians. This seems to us to be a crucial part of the puzzle. It appears that to date no accurate or detailed accounting has been carried out on a national basis. The Committee believes that it would be appropriate for the federal government, working closely with industry, to ensure that such baseline data are collected.

The final challenge to this sector, as identified by the Committee's witnesses, is shared by most of the resource sectors of our economy today: the financial challenge of dealing with increased environmental demands at a time when the industry is suffering from low prices and a very low return on investments. (The financial status of the industry is discussed more fully in Chapter 2.) The gas industry may see the situation improve in coming years if the volumes of gas sold increase and if prices do not decrease even further, but clearly all parts of the industry are feeling the effects of this poor performance. They will have to search for ways to meet environmental demands, while at the same time remaining competitive.

INDUSTRY'S RESPONSE TO THE ENVIRONMENTAL CHALLENGES

The natural gas industry is faced with both challenges and opportunities in the current climate of concern for the environment, and is responding to both. For example, even though the leakage rates for methane from the natural gas industry are relatively small, the industry is employing new procedures to control them even further. Work is underway on the use of "blowdown" compressors, which salvage the gas in pipe sections on which work is being done. Using this technique, the line is depressurized by drawing gas off the relevant section of pipe in question, through a compressor and back into the system, rather than simply bleeding it into the atmosphere.[8] In addition, the CGA will be working jointly with Environment Canada and Energy, Mines and Resources to verify the data on methane emissions from natural gas transmission and distribution systems, as part of an effort to establish an inventory of greenhouse gas emissions.[9]

In general terms, the industry has noted that at present ". . . we are not doing enough R&D, particularly on end-use."[10] In fact, according to industry representatives, this state of affairs is at least in part the result of a National Energy Board ruling. Until 1989, gas transmitters included in their cost of service a small amount that was sent to the Canadian Gas Research Institute (CGRI), an affiliate of the CGA, for research and development. In 1989 the NEB ruled that this money could no longer be used to fund R&D projects dealing with end-use, such as projects on emission reduction, increased efficiency and development of natural gas vehicles. The NEB ruled that since such projects did not deal with gas transportation they should not form part of the tariff for that transportation; as a result, funding for the CGRI dried up. The Committee would like to see this ruling reversed, through amending legislation if necessary. At the moment, natural gas research and development is being restructured within the industry. The Committee hopes that the programs will be re-established soon and supported through voluntary contributions from industry and other sources.[11, 12] In addition to the CGRI, the CGA and the individual gas transmission and distribution utilities carry on independent research and development work.

Despite these current difficulties, the industry has developed an impressive array of new technologies in recent years. As stated in virtually every other sectoral report, the natural gas industry sees improved efficiency as having the greatest potential in the short term to address most environmental challenges. In addition, efficiency measures add to the competitive advantage of gas through reduced operating costs. In fact, energy efficiency improvements will be the focus of much of the work under the revamped R&D program, building on the CGRI's already impressive record in this field.[13]

A short list of past CGRI projects with an efficiency component includes:

- high efficiency domestic furnaces and water heaters;
- domestic and commercial high efficiency heating/ventilation systems;
- high efficiency commercial water heaters and boilers;
- high efficiency scrap steel preheaters;
- evaluation of emissivity-enhancing coatings for industrial furnaces.

As the above list indicates, efforts have been aimed at the commercial, residential and industrial sectors. The advances in gas space heating systems, for example, have pushed efficiency levels for residential furnaces from 55-70% to over 90%. Advanced heat exchangers, forced draft combustion systems and more sophisticated controls have all been used to squeeze as much energy as possible out of the fuel.(14)

On the industrial front, new high-efficiency, high-temperature processes for the iron and steel, glass, pulp and paper and food processing industries are now available. As an example, in the steel industry, a new cokeless process is being used in which the scrap iron is melted using ceramic packing and natural gas burners in place of coke as the smelting medium. This system results in fewer emissions and offers a high level of quality control.

In addition to the above-noted accomplishments, the Canadian natural gas industry promotes new energy-efficient products through demonstration and evaluation programs carried out by the distribution utilities. Some recent demonstration programs are:

- residential engine driven heat pumps;
- natural gas fuel cells;
- commercial size absorption chillers;
- gas assisted electric heat pumps;
- infrared drying systems;
- cogeneration systems.(15)

The last item on this list, cogeneration, offers a great deal of potential for improving the efficiency of any endeavour where there is a need for both electricity and heat. The potential applications are widespread and range from industrial plants, to hospitals, universities, shopping centres, department stores and office buildings. Many of these facilities are located in urban areas where there is already a high level of pollution, and the efficient use of natural gas could significantly reduce harmful emissions. Cogeneration is not yet widely used in Canada, but already accounts for 5% of U.S. electricity generation, of which half is fired by natural gas. Canadian utilities and regulators are now looking more seriously at this option as they search for ways of meeting energy demands, while holding the line on emissions.

The transportation sector is the only sector of the economy not yet discussed with reference to the response of this industry to environmental challenges. Here, too, natural gas can make a contribution; for example, the Canadian Gas Association estimates that CO_2 emissions can be reduced by 30% by switching a car to use CNG (compressed natural gas) instead of gasoline. In addition, CNG vehicles emit less carbon monoxide and non-methane hydrocarbons.(16) If these environmental advantages are to hold up, the gas industry is aware it must work to ensure that the escape of methane during fuelling, operation and maintenance on CNG-fuelled vehicles is kept to a minimum, and at the very least, does not affect the aforementioned environmental advantages. The industry in Canada has not yet calculated the potential additional methane release from vehicles, but it points to a U.S. study which estimated that if all 200 million vehicles in that country were converted to natural gas they would account for only 0.02% of total world methane emissions. This is seen as a small price to pay for the sizable reductions in CO_2 and other emissions.(17)

The industry sees, of course, a potentially enormous market, and work is underway to try to expand the number of natural gas-powered vehicles in this country. To date approximately 30,000 vehicles have been adapted to dual-fuel capability,(18) so that they can run on either natural gas or gasoline. Dual-fuel capability is necessary because there are only 120 public and about 60 private refuelling stations across the country. Most of the vehicles are part of fleets with their own refuelling facilities. Further development of the natural gas vehicle (NGV) system poses a "chicken and egg" problem. There will be no more cars until there are more refuelling stations, but the reverse is also true; refuelling stations are expensive to build and so there must be more vehicles before more stations are put in place. In the meantime, many individual Canadian owners of NGVs are bridging the gap with a home refuelling system that taps into the residential natural gas supply. As costs of these units decline, and the speed of refuelling increases, this may well become a preferred option.

The next step in the evolution of an NGV system appears to be the imminent introduction of dedicated NGVs by North American automobile manufacturers including Chrysler, Ford, General Motors and an innovative Canadian company, Ontario Bus Industries. These new vehicles will be able to take full advantage of all the environmental benefits of natural gas because they will be designed "from the ground up" to run on this fuel. Chrysler is now producing 25 prototype dedicated natural gas vans at its Windsor plant. Ford plans to have three types of NGV—a passenger car, a light-weight truck and a medium-weight truck—available across North America by the 1994/95 model year. General Motors is aiming for the same model year with both light and heavy truck dedicated NGVs; this year it is producing 1,000 natural gas-powered trucks. The final player, Ontario Bus Industries (OBI), has been a leader in this technology for some time, having introduced the world's first dedicated natural gas bus—the Orion—in 1988. The Toronto Transit Commission has recently integrated 25 Orion buses into its fleet, and others are being marketed around the world. OBI is hoping to retain its world lead by working on the next generation technology, a hybrid natural gas/electric bus.(19) For many vehicle buyers, the attraction of NGVs is the fact that their fuel costs are 40-60% lower than gasoline; the environmental improvements are simply a bonus. If environmental costs are to be internalized the Committee feels that this type of price differential is appropriate.

ENDNOTES

(1) Howard Smith, Canadian Gas Processors Suppliers Association, *Minutes of Proceedings and Evidence*, House of Commons Standing Committee on Energy, Mines and Resources, Issue #4, 23 October 1991, p. 4:67.

(2) John Klenavic, Vice President, Canadian Gas Association, "Impact of Natural Gas on the Environment," *Energy and the Environment Symposium*, Sponsored by CANMET, Montreal, 20-21 March 1991, p. 6.

(3) Canadian Gas Association (CGA), *Natural Gas and the Environment*, A Submission to the House of Commons Standing Committee on Energy, Mines and Resources, September 1991a, p. 7.

(4) Canadian Gas Association, (CGA) *Global Warming*, Submission to the House of Commons Standing Committee on the Environment, December 1989, p. 4.

(5) Study by Alphatania Group, London, England, cited in CGA (1989).

(6) *Ibid*,p. 6.

(7) CGA (1991a), p. 18.

(8) CGA (1989), p. 6.

(9) Canadian Gas Association (CGA), Written Response to Questions Raised by the Committee, 23 October 1991b, p. 3.

(10) Ian McNabb, President, Canadian Gas Association, *Minutes of Proceedings and Evidence*, House of Commons Standing Committee on Energy, Mines and Resources, Issue #4, 23 October 1991, p. 4:34.

(11) CGA (1991b), p. 10.

(12) McNabb (1991), p. 4:33-34.

(13) CGA (1991a), p. 19.

(14) Klenavic (1991), p. 8.

(15) CGA (1991a), p. 22.

(16) CGA (1989), p. 7.

(17) *Ibid*, p. 8.

(18) Canadian Gas Association (CGA), "New Wave of Clean, Efficient Natural Gas Vehicles Will Soon Roll Off Production Lines," Press Release, 6 September 1991, p. 1.

(19) *Ibid*, p. 2.

CHAPTER 10

HYDROELECTRICITY

THE ENVIRONMENTAL CHALLENGES

Hydroelectricity is usually viewed as a safe, reliable, and environmentally friendly energy source. By and large this perception is correct. It is clear, however, that even this relatively clean energy source can have significant negative impacts on the environment.

Hydroelectricity is generated by the recovery of mechanical energy from running water. The water powers a turbine, which in turn activates an electrical generator. The amount of power that can be generated at any given hydroelectric generating station is determined by two factors: the rate of water flow and the height through which the water falls. If a particular site has a very high flow rate, then a lower height will suffice to allow effective generation. Conversely, a low flow rate can be compensated for by increased height of the fall, which can either be present naturally, or can be created by the construction of dams and reservoirs. The creation of a reservoir also allows for the managed flow of water to the turbines, evening out the natural variations in flow rate which are a response to seasonal fluctuations in precipitation. The construction of these dams and reservoirs can have a profound impact on the local environment. New evidence collected by Canadian scientists suggests reservoir creation may have a similarly profound impact on the global environment.

In its presentation to the Committee, the Canadian Electrical Association (CEA) noted that the generation phase for electricity is essentially pollution free, with no changes to the physical or chemical nature of the water, no raw materials consumed and no waste material produced.(1) However, the Association does go on to acknowledge that new hydroelectric developments are facing increased opposition due to competing land uses, native rights and concerns over habitat conservation. More recently, there has also been concern over the production and release from reservoirs of the greenhouse gases methane and CO_2. In general terms, the CEA noted that, to a greater or lesser extent, all the major environmental impacts of hydroelectric developments stem from two fundamental characteristics: flooding and riparian (river bank) changes. Concerns have been raised by some researchers regarding the health effects of the electromagnetic fields generated in high tension power lines carrying electricity. The Committee notes that this poses a potential environmental challenge for this sector.

Hydraulic power stations function through concentrating the natural drop of a river into a single location by increasing the water level over the upstream sections of the river system. Depending on the topography, the water levels in tributary streams and any lakes in the affected part on the system may also be increased.(2) Many of the recent and planned hydroelectric developments in Canada are in sparsely-populated northern regions with fairly low relief. This requires the creation of vast reservoirs to create useable hydrostatic pressure and acceptable operating conditions.(3)

As a result of the flooding that follows the construction of such power complexes, the natural mechanical (erosion and sedimentation) and biological regimes are disturbed and it takes many years for a new equilibrium to be established. In the intervening years, problems will be created by changed patterns of erosion and sedimentation in the reservoir and in the affected streams and lakes. Of even more concern, however, is the impact on the environment of the sudden submersion of large amounts of organic material (trees and peat for example), and its subsequent decomposition. When organic materials are flooded, an initial period of very rapid degradation depletes the dissolved oxygen in the water. This creates an anoxic environment, in which anaerobic bacteria take over the degradation process.

This process converts inorganic mercury, present naturally in the environment, into organic or methyl mercury, which is more fat-soluble than the inorganic form, and so can accumulate in animal tissue. The problem is intensified up the food chain through bioaccumulation so that the fish in affected reservoirs contain mercury levels that make their consumption in large quantities dangerous to human health. This is especially so for the health of native populations in the regions affected, where fish makes up a significant part of the traditional diet.

The methyl mercury created is a direct and proven hazard to human health. It is believed that the concentration of methyl mercury in the fish will remain poisonously high for at least 40 or 50 years.

The same anaerobic conditions that cause the mercury to accumulate are now thought to be responsible for the increased release of greenhouse gases from reservoirs. Under aerobic conditions, the decomposition of organic matter results in the production of CO_2. When the conditions become anaerobic, as in a recently flooded reservoir, both CO_2 and methane are produced. Methane is more than 30 times as "effective" as a greenhouse gas than CO_2. Clearly, the increased production of these two gases would have an impact on the global warming problem. Dr. John Rudd, the leading researcher in this area, appeared before the Committee; he cautioned us to remember that the contention that methane is produced in large quantities is hypothetical. Nonetheless, the hypothesis is being taken seriously and research is underway to test its validity.(4) It is accepted that methane is formed and emitted under such conditions; what is being determined in the current round of testing is the volume of methane produced. It will be four or five years before the final results of the project are available. If the results show that greenhouse gas emissions from man-made reservoirs are similar in "effectiveness" to, or even exceed those of fossil-fuel electricity generation, on a per unit of energy generated basis, the image of hydroelectricity as an environmentally benign energy source would indeed be tarnished.

Hydraulic power installations also have an impact on the nature and extent of ice cover in waters upstream and downstream of the plant, and on the thermal regime of the reservoir and the part of the river immediately downstream of the plant.(5) In addition, the management of water flow from the reservoir can have an effect on the natural flow cycle, which in turn can affect fish and wildlife in the area. The CEA told the Committee that almost all hydraulic stations have some impact on fish populations. The increased amount of water stored in the reservoir sometimes increases the total number of fish, but the types of fish present may

change, with riverine species being replaced by lacustrine (lake dwelling) species. In some cases, the generating station may prevent the upstream migration of anadromous species such as salmon, and action must be taken to alleviate the problem.

Downstream in the estuaries and in the marine environment, flow variations due to hydraulic station operations also change temperatures, tides, freshwater variegation and the position of the salt water wedge. These changes can affect plankton, aquatic plants, fish, waterfowl and even marine mammals such as beluga whales and seals. Environmental follow-up studies on the La Grande project over the last ten years have shown that these ecological changes have not perceptibly harmed fish populations in the estuaries.[6, 7, 8] In particular, it appears that even the elimination of spring flooding does not change the biological productivity of the northern marine environment because rivers at that latitude do not normally carry many nutrients to the estuaries. Furthermore, the species present have already adapted to significant natural variations in salinity.[9]

As well as affecting the fish population, hydraulic installations have an impact on much of the flora and fauna living in the area, particularly those living along the shorelines of the affected lakes and rivers. Such impacts can be devastating. Alberta's Peace-Athabasca Delta is being dessicated, and the wide variety of plant and animal life it supported greatly reduced, in consequence of upstream flow control exercised by B.C.'s Bennett Dam. At installations where water level fluctuations, especially after freeze-up, are significantly higher than under natural conditions, small fur-bearing animals, principally beavers, can have a very high mortality rate. For larger mammals, such as caribou, the loss of habitat from flooding or downstream flow restrictions does not pose a serious threat if they can find comparable habitats nearby. It is not known what percentage of larger mammals compelled to seek new habitat prove successful, nor how far they have to travel in their searches.

There is also concern in some quarters of the effects of increased sediment loads which may result from the construction of hydroelectric installations in some locations. The change in sedimentation rate can change the dynamics of the estuaries where the rivers enter lakes or the sea, and this in turn can affect the animal and plant species found there. The Committee did not hear any testimony regarding this issue but thinks it worth noting as one of the environmental challenges which the hydroelectric sector faces in some locations.

INDUSTRY'S RESPONSE TO THE ENVIRONMENTAL CHALLENGES

The hydroelectric industry recognizes that many of its environmental impacts, such as the increase in fish mercury levels following the creation of a reservoir or the destruction of downstream habitat, cannot be mitigated. In response to the needs of the native population for a replacement for this essential part of their diet, utilities and native groups are investigating the potential for aquaculture that somehow will be able to avoid methyl mercury contamination. Further, it must be remembered that pursuit of this option can also cause serious environmental problems, such as disease propagation in fish populations. Other impacts on the fisheries are also addressed routinely by Canadian utilities through such initiatives as the installation of fish-ladders to help migrating species, the use of screens on water intakes to protect the fish, the control of discharges and water levels to facilitate spawning needs and the operation of hatcheries and the release of fingerlings. The CEA told the Committee that its members support the principle of "no-net-loss fisheries."[10]

The serious implications of Dr. Rudd's hypothesis for the industry are well understood by the utilities. They are concerned, but not alarmed at this stage. The CEA is, in fact, one of the organizations funding the work by Dr. Rudd. The utilities want to await the results of this research before taking any further steps.

In general terms, the industry indicates that it is prepared to meet its environmental challenges, which seem to be fewer and less severe than those of many other energy sources. The generation of electricity by hydraulic means can play a significant role in minimizing the use of fossil fuels to generate electricity, thereby helping to alleviate such environmental issues, as acid rain, and perhaps global warming.

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CHAPTER 11

BIOMASS ENERGY

INTRODUCTION

At the time of Confederation, the Canadian energy supply was derived 90% from biomass and 10% from other sources such as coal and waterpower. The importance of bioenergy rapidly declined as coal and then oil became the fuels of choice. By 1970, biomass contributed only 3% to the national energy supply.(1) The energy crisis of the 1970s revitalized interest in bioenergy, and was responsible for a national surge in renewable energy research and development. Today biomass contributes approximately 8% of Canada's energy supply.

The largest users of biomass are forest industries such as pulp and paper mills and sawmills which burn forest residues, sawmill debris and spent pulping liquors as a cheap source of energy. In pulp and paper mills, waste combustion provides much of the process steam required for the chemical pulping process. At sawmills, process heat is used to dry lumber. For many large mills the cost of using biomass is very attractive when the combustion of wood wastes is used to produce both process steam and steam for electricity generation. Next in importance in terms of biomass consumption is the use of wood for residential heating. The convenience and relatively low price of natural gas, oil, and electricity currently limits the use of biomass in other areas. In the absence of government regulatory intervention, or significantly altered taxation regimes, expansion of the biomass energy market will largely depend upon higher petroleum prices or consumer willingness to pay more for energy sources that are less harmful to the environment.

ENVIRONMENTAL CHALLENGES AND SOLUTIONS

A. Direct Combustion of Wood

The use of biomass as an energy source is not generally viewed as presenting environmental challenges. On the contrary, biomass receives wide support as a renewable alternative energy source that does not deplete fossil fuels and offers more potential environmental benefits than conventional fuels. The expanded use of biomass and biomass-derived fuels promises to decrease pressure on landfill sites, improve urban air quality, and reduce carbon dioxide emissions. This, however, is modified by the fact that many of the traditional furnaces, stoves and fireplaces used to burn wood and wood wastes operate at very low efficiencies and release high levels of pollutants.(2)

When wood is burnt in the open, the temperature of combustion is not high enough to reduce the wood completely to inorganic gases and ash. During the combustion reaction, particulate matter and volatile organic compounds are formed which escape from the flame

area before they are completely burned. This also happens in fireplaces and to a somewhat lesser degree in most furnaces and stoves that were not designed to be energy efficient. According to the Biomass Energy Institute's submission to the Committee, a Newfoundland study showed that the oil required to heat 100 homes would release 3 kg of particulate matter per year. In comparison, heating the same 100 homes by means of roundwood furnaces would release a minimum of 6,000 kg of particulate matter, a 2,000-fold increase. Table 11.1 compares pollutant emissions per unit energy for wood and coal. As these data indicate, more particulate matter and more carbon monoxide are released from the combustion of wood than from coal.(3)

Table 11.1
Common Pollutants from the Combustion of Coal and Wood

	Average Pollutant Concentration (g/Gigajoule)	
	Coal	Wood
Particulates	300	500
Carbon monoxide	5,000	8,000
Hydrocarbons	400	150
NO_x	40	20
Sulphur dioxide	900	0

Concern for pollutants from coal combustion has stimulated the development of clean-coal technologies. Combustion and post-combustion (scrubbers) technologies have led to substantial reductions in the release of SO_2, NO_x and particulate matter. Improvements in combustion efficiency have led to less CO_2 released per unit of energy.(4) Adaptation of some of these improvements to wood furnaces has allowed the large industrial facilities that burn wood and wood wastes to meet environmental standards for air emissions, effluents, and solid waste.

There are very stringent environmental emission regulations for "energy-from-waste" incinerator facilities, because of the fear of possible dioxin and furan production. State-of-the-art incinerators have been designed for which manufacturers and users claim up to "eight nines" (99.999999%) destruction and removal efficiency (of the waste) can be achieved. In facilities that handle a mixed waste such as municipal solid waste, proponents claim that destruction and removal efficiency seldom drops below 99.99%, and that emissions from efficiently operating incinerators are cleaner than those from comparably sized industries.(5) The Committee cautions that destruction and removal of either dioxins and furans or of the waste itself operating at a rate of 99.99% efficiency should be seen as the "ideal" operating scenario, perhaps occasionally but never consistently achieved. Municipal

incinerators often smoulder, and several reputable articles have been published indicating that "state-of-the-art" incinerators for hazardous waste often operate at well below their rated efficiency.[6]

Residential wood furnaces, stoves and fireplaces are potentially a significant source of airborne pollutants. However, except in fireplaces, little wood is used in urban areas for home heating, and consequently wood smoke seldom spoils the air quality in highly populated areas. Energy-efficient wood stoves and burners for home heating have been developed. These are essentially catalytic designs where the fugitive gases are recycled to the combustion chamber. In comparative tests the efficiency of catalytic stoves was 27% better than that of conventional wood stoves, and pollutant emissions were greatly reduced (a 10% improvement in NO_x emissions, 54% for carbon monoxide, 81% for hydrocarbons, 90% for particulate matter, and 93% for polycyclic aromatic hydrocarbons).[7,8,9]

B. Deforestation

Canada has received harsh international criticism for its non-sustainable forestry practices, and the destruction of old-growth forests. Increased biomass use could place even greater demands on forest reserves. In addition to the concern of sustained yield, forest soil quality must be considered, and efforts made to replenish soil nutrients and prevent erosion.

Future bioenergy demands may be supplied by biomass crops produced by new forestry techniques like those used in modern agriculture. Fast-growing tree species, such as willows, aspen and cottonwoods, can be grown by short rotation intensive culture (SRIC). Wild-type willows grown by this method have productivities of 10 tonnes per hectare per year, and could be produced in 1991 at a cost of $33 per tonne. This was a definite cost improvement over the standing timber price at the time of $40 per tonne. Proponents claim that genetic engineering and classical breeding and selection techniques have led to greatly improved strains, with productivities approaching 30 tonnes per hectare per year. It has been estimated that tree plantations using new strains and methods could supply biomass at a cost of $23 per tonne.[7,8] Yields of up to 20 tonnes per hectare per year have been recorded using selected strains grown with high fertilizer and other inputs.

SRIC, or tree farming, is well suited to marginal or idle farm lands, and offers the potential for economic diversification in depressed regions. However, more intensive tree farming usually entails greater use of herbicides, pesticides and fertilizer. These inputs often have significant adverse environmental effects. In addition, SRIC is usually practised with tree monocultures that are often more susceptible to disease, although propagation of mixtures of types and species may reduce this problem. On the plus side, expanded use of SRIC could conceivably relieve some pressure on mixed forests and, to some extent, possibly even old-growth forests.[10]

An additional environmental benefit from the rapid production of tree biomass is the corresponding rapid incorporation of carbon dioxide into plant material. When this biomass, or biomass-derived fuel, is burnt for energy production its use can be seen as "backing out" or replacing fossil fuels which, presumably, otherwise would have been used; so it reduces the amount of new carbon taken up from the lithosphere and deposited in the atmosphere. As such, bioenergy is often not a net contributor to the greenhouse effect.[11, 12, 13, 14]

C. Biomass Handling and Preparation

Tree harvesting and transportation are energy-intensive operations that are heavy consumers of fossil fuels and sources of pollutants. Energy, Mines and Resources Canada is funding research to develop more efficient and reliable handling systems.

Wood has a lower energy content than most currently used fuels. For example, on a volume basis, coal contains four times more energy than wood. Transportation costs for wood and wood wastes place this energy source at a distinct disadvantage. Additional disadvantages to the use of wood are its variable moisture content and lack of homogeneity. To lessen the cost and disadvantages of biomass, research is being funded to develop improved methods of storage, measurement, metering and feeding. Of prime importance is the development of new equipment for wood segregation/ mixing, comminution, drying, compaction and pelletization.[15]

THE FUTURE OF BIOMASS

During the early half of the 1980s, Energy, Mines and Resources Canada supported ambitious research and development activities in biomass pyrolysis, anaerobic digestion, and the biochemical conversion of biomass to fuel ethanol and chemical feedstocks.[16] Abundant supplies of clean, low-cost natural gas have hindered the implementation of these technologies, with the exception of fuel ethanol production. Fuel ethanol research resulted in a number of significant technological advances, so that the cost of ethanol production from biomass has dropped dramatically. Further advances are expected to make wood-and grain-derived ethanol competitive with gasoline in the next five years. Competitive cost and the environmental benefits of ethanol suggest that ethanol may capture a share of future transportation fuel markets.

A. Environmental Benefits of Fuel Ethanol

One of the more important driving forces for development of a fuel-ethanol industry is public concern for human health and environmental quality. Petroleum combustion produces atmospheric emissions that pose a human health risk, degrade aesthetic air quality, and contribute to the global climate change. Compared with gasoline, ethanol is a purer, cleaner-burning fuel.[17] It has a higher oxygen content, which promotes more complete burning, thereby improving energy efficiency. On a volume basis, ethanol has a lower energy content than gasoline. However, ethanol as a 10% blend in gasohol improves efficiency to a level that compensates for its lower energy content.

In test vehicles, complete or partial replacement of gasoline with ethanol had little or no effect on nitrous oxide emission. However, ethanol combustion produced less carbon monoxide and fewer hydrocarbon emissions. Again, this is due to the oxygenate effect of ethanol, which improves the oxidative combustion of carbon monoxide to carbon dioxide. A number of American mountain states with serious cold weather carbon monoxide problems, mandate the use of ethanol-oxygenated fuels in winter.[18, 19]

Ground-level ozone poses one of the most pervasive and persistent urban air quality problems.[20] It is produced photochemically from non-methane organic gases, such as carbon monoxide and fugitive hydrocarbons that are released as evaporative emissions or through incomplete combustion. Although ethanol use often increases evaporative emissions, it can result in decreased carbon monoxide production, thereby reducing overall ozone production.[21] Available emissions data indicate that a reduction of about 20% in urban ozone levels might be attained if gasoline were completely replaced by neat (100%) ethanol. In addition, such a switch to pure ethanol would improve fuel efficiency and reduce the amount of carbon dioxide released per unit energy by 12%.[22]

Use of ethanol-blended gasoline also would result in reductions in formaldehyde, toluene, benzene and 1,3-butadiene.[23] These compounds are all toxic and benzene is a known carcinogen. Ethanol should be expected to produce increased levels of acetaldehyde, a moderately toxic compound and an ozone-precursor compound. Acetaldehyde, like formaldehyde, can be removed in specifically-designed catalytic convertors. Ethanol also has the advantage of being able to raise the octane rating of fuels in the same way as lead additives; and could replace the controversial octane enhancer, MMT (methyl manganese tricarbonyl cyclopentadiene), now used in Canada.[24]

B. Grain Ethanol

For ethanol to compete with gasoline as a neat fuel it must sell for $0.20 per litre at an oil price of $20 per barrel, and $0.30 per litre at an oil price of $33 per barrel.[25] In countries where ethanol is produced from biomass, government subsidies are paid, and are justified principally on the basis of energy security and agricultural support. Established ethanol industries exist in Brazil, where 14 billion litres are produced annually from sugar cane, and in the United States, where 3 billion litres are produced from corn. In Canada, a much smaller industry (23 million litres) is based on western Canadian grain.

Mohawk Oil, Minnedosa, Manitoba, and its Poundmaker Ethanol Plant in Lanigan, Saskatchewan, are the main facilities producing fuel ethanol in Canada. At Lanigan, the protein-rich grain mash remaining after distillation is fed to cattle to obtain by-product credits. Mohawk Oil sells its by-products to cattle-feed distributors in the United States and Europe as distiller dried grains. At these plants, ethanol is produced by traditional brewing technology. According to Mr. J. Johnson, President, Canadian Renewable Fuels Association, this ethanol can be produced at a cost of $0.40 to $0.45 per litre, based on a grain cost of $3 per bushel. The ethanol is blended with gasoline and sold as a premium, high-octane fuel in a 10% blend in Manitoba and Saskatchewan and in a 5% blend in B.C. and Alberta. Ethanol produced from grain grown in the province and added to gasoline used in the province receives a provincial subsidy of $0.35 per litre in Manitoba and $0.40 per litre in Saskatchewan. With the subsidy and by-product credits, the production of grain ethanol is economically viable in these four provinces.

The Committee notes with interest that the development of ethanol-blended fuels received a healthy dose of fiscal encouragement from the federal government in its February 1992 budget. The government acted to remove the 8.5 cent-a-litre federal excise tax which had been in place on ethanol. In terms of prices at the pumps, this stimulative tax measure translates roughly into a 0.9 cents per litre price reduction for a 10% ethanol-blend gasoline.

The federal tax initiative has been well received by ethanol proponents, who argue that the blended product will now become price competitive with gasoline while at the same time delivering higher octane levels and ensuring environmental benefits. Preliminary indications suggest that the budgetary move will result in new investment in ethanol plant and facilities, particularly in Ontario. It could also be of considerable benefit to Canadian grain farmers, corn producers especially, who would be in a position to provide inputs to the production process.

Two points of caution need to be made to temper the optimism for this fuel option. In keeping with a subsequent recommendation for full fuel-cycle analysis on environmental impacts, the Committee wishes to note that the environmental gains to be made through ethanol production are not entirely proven. The Committee also holds some doubts regarding the availability of input stock in the case of a large-scale shift in consumption to an ethanol-blend based on grain-derived ethanol.

Ethanol production from Canadian grain could be sufficient to replace 10% of Canadian gasoline requirements (approximately 34.5 billion litres annually). A 10% blend would require 3.45 billion litres of ethanol, and would consume 9 to 10 million tonnes of grain. Canada's annual production of principal grains totals between 50 to 60 million tonnes. Therefore, ethanol production, to reach the 10% blend level in all gasoline sold, would require slightly less than 20% of the annual grain harvest.[26, 27] As attractive as this may sound, particularly to economically-stressed prairie grain farmers, a poor harvest or improved international markets would increase grain prices. Sufficient grain might not always be available to a newly established fuel-ethanol industry, or not at a price that would render the process economical.

C. Wood Ethanol

The high and variable cost of grains prompted Energy, Mines and Resources Canada also to fund the development of technologies for the production of ethanol from plentiful and low-cost lignocellulosic materials (wood, wood wastes, agricultural residues, herbaceous crops, and municipal wastes). Unlike grain, which could, under current conditions, produce only enough ethanol to replace a moderate percentage of Canada's gasoline needs, annual lignocellulosic biomass production has the potential to produce liquid transportation fuels on the same scale as oil.[28]

Conversion of lignocellulose to ethanol requires a number of basic unit operations: pretreatment, cellulase enzyme production, enzymatic hydrolysis, fermentation and ethanol recovery. Although this technology is in its infancy, dramatic achievements and cost reductions have been achieved in the past decade. Using present-day, pilot-plant technology it is possible to produce ethanol at a cost of $0.45 to $0.51 per litre.[29, 30]

Steam explosion, a pretreatment process developed in Canada, is considered "state-of-the-art," with little room for economic improvement. Similarly, fermentation and ethanol recovery are mature technologies where it is thought that additional improvements will yield only modest cost savings. Enzyme production and hydrolysis are the two steps where future research is expected to result in significant cost reductions. The application of recombinant DNA techniques is expected to improve enzyme production and catalytic

capabilities, and could allow the production of "tailor-made" enzyme preparations. The major hydrolysis problem is the time-dependent loss of enzyme activity. It is possible that a greater understanding of the cellulose-enzyme structure-function relationship and the mechanisms of activity loss will lead to commercial development that will dramatically improve the economics of enzymatic hydrolysis and may allow enzyme recycling.[31, 32] Research on these problems is being conducted at a number of Canadian universities, and by Iogen Corporation of Ottawa.

The final area where cost reductions are expected is the cost of biomass. The $0.51 per litre ethanol cost is based on the current standing timber price of $40 per tonne. As previously mentioned, biomass may be produced by SRIC at a cost of $23 per tonne. Recycling of municipal and industrial paper and wood wastes is now being practised in many North American cities. As landfills rapidly become filled, dumping fees increase; within a 100 km radius of Toronto, landfill tipping fees of $150 per tonne are common.[33] Redirection of wood wastes would save urban municipalities money and supply an emergent wood-ethanol industry with substrate at very low cost. Increased consumer demand for recycled paper has resulted in another source of cellulose. Paper can only be recycled a limited number of times before the cellulose fibres become too short and weak to make newsprint. Approximately 20% of the cellulose is collected as waste fibre, which is an excellent source of pretreated cellulose for ethanol production. Many experts in both Canada and the United States firmly believe that further process improvements and the development of new by-product markets will drop the cost of ethanol production to $0.21 (Canadian) per litre within the next 5 to 10 years.[34, 35] Research scientists at the Denver-based National Renewable Energy Laboratory estimate that the cost of ethanol production can be reduced to $0.16 per litre by the end of the decade.[36] At this price even pure ethanol could be competitive with gasoline without the benefit of subsidies.

Mr. B. Foody, President, Iogen Corporation, told the Committee that the development of a wood-ethanol industry in Canada would be best fostered by a strong federal government commitment to the stabilization of carbon dioxide emissions. Complete or partial replacement of gasoline by fuel ethanol would go far towards achievement of this goal. Recognition of the government's commitment and knowledge of the environmental benefits of ethanol would, it was argued, necessitate a wood-ethanol industry and stimulate the required capital.

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CHAPTER 12

WIND ENERGY

INTRODUCTION

No discussion of the sustainability of our energy system would be complete without consideration of the renewable sources of energy available to us. Over the past decade there have been significant advances, one example of which is the technology associated with wind energy. The progress has been so pronounced that people are beginning to look at this energy source with renewed interest, particularly as societies around the world grapple with the problems of meeting growing energy demands (particularly for electricity) without ruining the world's environment.

In terms of its environmental impact, wind energy offers obvious advantages. Supplying electricity from this source produces no NO_x, no VOCs, no SO_2, no CO_2 and no other greenhouse gases at the generation phase. In the past, questions about wind energy have centred on how much of our energy it could supply in a cost-effective and reliable manner. The Committee heard of major cost reductions and improvements in reliability achieved by the wind energy industry in the last 10 years.

The proponents of renewable energy sources have long called for a "level playing field" in order to make these sources competitive with conventional energy sources. They claim that government support for research, development and demonstration has been unfairly distributed between conventional and renewable sources. Their complaints are even more valid today, as government support for renewable energy R&D has been cut to the bone over the last decade.

Renewable energy proponents also stress the need to take all costs into account when comparing the various energy options, including the environmental and social costs. With the current concern over the environmental impact of conventional energy sources, methodologies are being worked out to include these costs and wind energy is poised to compete head on with conventional sources. In fact, only recently a U.S. company revealed a new wind turbine which, it claims, can produce electricity at a cost that can compete with conventional generation technologies, even without a level playing field.(1)

Clearly the future looks hopeful for the wind energy industry. The few environmental challenges facing it are different from those faced by conventional sources, but nonetheless have to be addressed as do a number of other barriers to greater wind energy development. The industry is confident that these obstacles can be overcome to allow wind energy to do its part in making sustainable energy development a reality.

POTENTIAL CONTRIBUTION TO ENERGY SUPPLY

Wind energy does not make a significant contribution to Canadian energy supply at the present time. There are a number of installations in remote communities, particularly in the north, and one large (4 megawatt) wind turbine was feeding electricity into the Hydro-Quebec grid from Cap-Chat, Quebec. In addition, the Southwest Alberta Renewable Energy Initiative is supporting the installation of two megawatt-scale wind farms at its Pincher Creek site, to be completed by the fall of 1993. The installations will be of 9 and 9.9 MWs respectively.(2) It is hoped that these demonstration projects will prompt consumers from various sectors to re-evaluate the potential of wind energy. The company involved in the 9 MW project intends to install turbines using a new U.S. technology which features a variable-speed generator instead of the standard induction generator. The change promises to extract from 15 to 20% more energy out of the wind than is at present achieved with the same diameter rotor.(3,4) The second project will employ Danish technology.

Other countries in the world have seized on wind energy technologies much more enthusiastically than Canada. For example, since the oil crises of the mid-1970s, over 20,000 wind machines, with an installed capacity of 1800 megawatts (equivalent to three Point Lepreau Nuclear Stations) have been built worldwide. Most of this construction has been in Denmark (2,700) and in California (17,000). Denmark now gets some 2% of its electricity (200 Megawatts) from wind power, which it hopes to increase to 10% by the year 2000.(5) Germany and the Netherlands each plan to install 200 MW of wind power by 1995 and other European countries are following suit. In fact, long range plans in Europe could see as much as 1,000 MW per year added, with a total of 100,000 MW by 2030.(6) In California, some two billion kilowatt hours (kWh) of electricity are generated by wind power every year.

The above figures show that wind energy is already playing a significant role in the world's energy supply. It has been estimated that, from a strictly theoretical point of view, wind could provide all of the world's current electricity demand.(7) More realistically, of course, one has to look at the economic potential, not the theoretical. Some have estimated that by the year 2030, for example, as much as 20% of U.S. electricity could be economically generated from this source.(8)

Canada too has significant potential for wind energy, with a recent publication by Energy, Mines and Resources setting the technical potential at some 27,000 MW, of which an estimated 4,500 MW is seen as being easily tapped over the next 25 years.(9) In other words, depending on how aggressively we want to pursue this option, (and apparently that is less aggressively than the U.S. studies imply) between 1 and 5% of Canadian electricity could be generated by wind power in the next quarter century. Before this can happen, however, a number of barriers have to be removed. These barriers include the lack of a detailed and comprehensive assessment of resources, which makes it difficult for utilities and/or individuals to gauge whether or not wind energy is viable for their needs; high cost per unit of production given small-scale production capacity per unit of required investment; and major utility reluctance to permit widespread "feed-in" of small-plant-generated electricity to the main grid.

ENVIRONMENTAL IMPACT OF WIND ENERGY

Wind energy is recognized as one of the most environmentally benign technologies capable of generating utility grade electricity.[10] As noted in the introduction, it produces no atmospheric pollutants at its generation phase. Though, admittedly, modern wind turbines do involve the use of many nonrenewable substances, whose production may cause environmental damage, this damage is much less than that caused by most other energy sources. Industry representatives told the Committee that the few negative environmental effects are of a "cosmetic and attitudinal nature and not a safety or environmental concern."[11] The Committee would caution the industry representatives not to disregard or under-estimate environmental problems associated with their industry. It is expected that soon it may be necessary to obtain a licence to build a wind farm, just as must now be done for conventional power stations.

One concern often raised in discussions of wind energy is the noise pollution that may be produced by a large installation. The industry believes this problem can be addressed by good blade design, careful siting and the use of sound-absorbing components and materials where needed. Visual intrusion is also a problem which can be mitigated to some degree by careful attention to site selection, spacing of turbines and choice of type and size of equipment.

There is some concern about possible damage to plant and animal life, in particular to certain raptor bird species, as a result of wind energy production. According to the Canadian Wind Energy Association, wind turbines pose no greater threat in this regard than do conventional transmission towers and wires. Furthermore, careful construction practices will minimize erosion during construction, after which the land can be returned to agricultural uses. The land area requirement for wind power systems is smaller than that for many competing technologies.[12]

POTENTIAL FOR POLLUTION REDUCTION

Given the fact that there are no atmospheric emissions from the generation of electricity from wind power, this method of production offers a great deal of potential in helping countries around the world meet their emission reduction targets. In fact, the ability of the wind energy industry to reduce pollution produced by conventional sources is one of its principal attractions. Using conservative assumptions, at 7 cents/kWh (kilowatt hour), the cost effective potential for wind power in Canada would be the 4,500 MW noted above. This is equivalent to 4% of Canada's total installed electrical capacity in 1991. The tonnage of pollutants avoided would depend, of course, on the conventional source replaced. As an example, comparing 4,500 MW of wind power operating at an average capacity factor of 25% with an equivalent 1,500 MW unscrubbed, coal-fired station at 75% capacity factor, would see a reduction of 52,232 megagrams of SO_2-one-third of Ontario Hydro's current target for SO_2 reduction.[13]

Another study offers the following estimate of CO_2 reduction potential, based on the assumption that every 250 kilowatt wind turbine at a site with a strong and steady wind regime will eliminate from 500–1,000 tonnes of carbon emissions each year. In 1990, the 14,000 wind

turbines operating in California prevented the generation of more than 5,400 tons of various pollutants in addition to nearly 5 million tons of CO_2, which would have been produced by a hypothetical plant burning a mixture of oil and natural gas to generate the same power.[14] For coal-fired generation using standard, current technology the effect would be even greater.

With growing international concern over the impact of electricity generation on the environment, a number of governments are in the process of developing methodologies to allow them to factor environmental costs into their electricity planning efforts. This is a very new area of research and is proving to be a difficult task. A number of attempts have been made, in the U.S., for example, to quantify the environmental costs of energy[15] and, from all indications, wind energy fairs very well when such an analysis is completed.

EMERGING TECHNOLOGIES AND COSTS

The technology of wind energy changed considerably through the 1980s. There has been a trend towards large diameter grid-connected machines and there is strong competition internationally among producers of machines in the 25–28-metre diameter (225–300 kilowatt (kW)) range. Some rotors of 33 and 35 metre diameter (400–500 kW) are now also commercially available and there is work at the precommercial stage on 600-700 kW machines.[16]

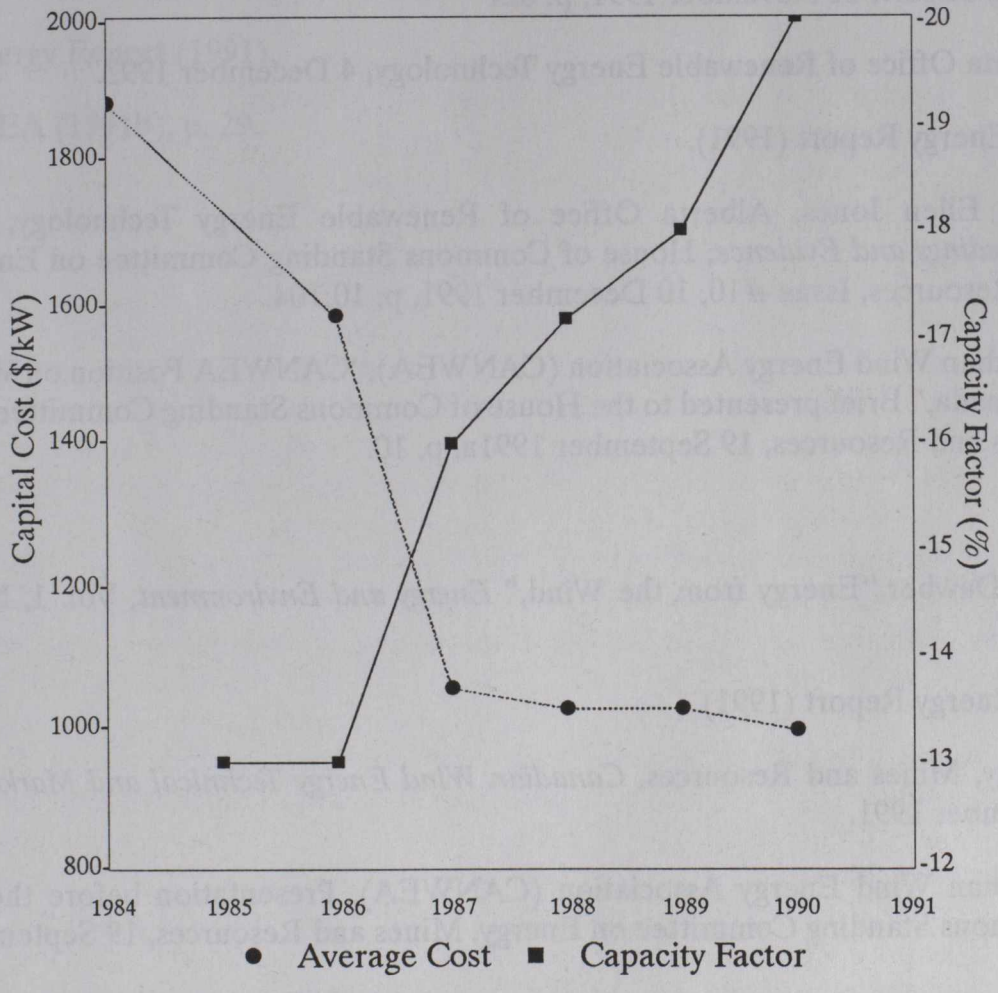
The size of the blade is not the only area in which research is bearing results. An American company has recently announced that it has developed a variable speed generator for its wind energy systems which will increase by 20% the energy extracted from a given wind turbine.[17] The 33-metre, variable-speed technology is expected to produce electricity at a cost of just 5 cents/kWh, compared to the current technology which produces power at between 7 and 9 cents/kWh. If the production models live up to the prototype performance, this technology will make wind power competitive with utility systems in many locations and represents a significant advance for the industry. The cost mentioned above of 5 cents/kWh, is a far cry from the 25 cents/kWh which was typical a decade ago. The 5 cent figure does represent the latest advances and 7 to 9 cents is probably more typical of today's average.

In terms of reliability, wind energy has also made significant gains over the past decade. Once seen as an unreliable source of energy, experience, particularly in the U.S. and Denmark, has shown that reliability has risen as sharply as costs have fallen. For example, in Denmark the average "unavailability" of its wind turbines is just 70 hours/turbine a year, of which 33 hours are for regular maintenance.[18] Figure 12.1 illustrates this progress very dramatically.

Canada does not have a large indigenous wind turbine manufacturing capability and so there is not a great deal of potential for exporting this technology. We will be hard pressed to catch up to Danish and American producers, given their large market and their considerable head start. Our potential lies in exporting our expertise in off–grid applications, and in particular, our wind/diesel hybrid systems. Third World countries will be a great market for this sort of technology, as will any jurisdiction in which there are remote, isolated communities not connected to the grid, and currently powered by expensive (and polluting) diesel generators.

FIGURE 12.1

Wind Industry Performance and Cost



Source: Canadian Wind Energy Association, Presentation to the House of Commons Standing Committee on Energy, Mines and Resources, 10 December 1991, p. 22.

BARRIERS TO INCREASED USE

To be successful, the wind energy industry would require a champion in government. The industry believes that a government that signals that wind energy is a viable option and should be considered by consumers making supply decisions, would go a long way to improving the current situation. A more balanced playing field, in which all costs, including social and environmental costs, are taken into account would allow wind energy to play a significantly greater role in Canada. The Wind Energy Association would like to see the federal government lead Canadian efforts to internalize these costs and conduct a thorough wind resource assessment.

ENDNOTES

(1) "Producer Says New Turbines Put Wind Energy on Same Footing As Other Energy," *The Energy Report*, 11 November 1991, p. 821

(2) Alberta Office of Renewable Energy Technology, 4 December 1992.

(3) The Energy Report (1991).

(4) Mary Ellen Jones, Alberta Office of Renewable Energy Technology, *Minutes of Proceedings and Evidence*, House of Commons Standing Committee on Energy, Mines and Resources, Issue #10, 10 December 1991, p. 10:104.

(5) Canadian Wind Energy Association (CANWEA),"CANWEA Position on Wind Energy in Canada," Brief presented to the House of Commons Standing Committee on Energy, Mines and Resources, 19 September 1991a, p. 10.

(6) *Ibid*.

(7) K.R. Dawber,"Energy from the Wind," *Energy and Environment*, Vol. 1, No. 3, 1990, p. 227.

(8) The Energy Report (1991).

(9) Energy, Mines and Resources, *Canadian Wind Energy Technical and Market Potential*, November 1991.

(10) Canadian Wind Energy Association (CANWEA), Presentation before the House of Commons Standing Committee on Energy, Mines and Resources, 19 September 1991b, p. 17.

(11) CANWEA (1991a), p. 16.

(12) *Ibid*.

(13) Jeff Passmore, Passmore Associates, Brief to House of Commons Standing Committee on Energy, Mines and Resources, 11 December 1991.

(14) CANWEA (1991a), p. 12

(15) Richard Ottinger, "Environmental Costs Of Energy," Report Prepared for New York Energy Research Authority and U.S. Department of Energy, 1990.

(16) CANWEA (1991b), p. 19.

(17) The Energy Report (1991).

(18) CANWEA (1991b), p. 29.

CHAPTER 13

SOLAR ENERGY

INTRODUCTION

At the moment, hydro and biomass account for almost all of the "renewable" energy contribution to Canadian energy supply. However, like wind energy, solar energy has the potential to make a significant environmentally benign contribution in the future. The amount that it contributes will depend on a number of factors, including technological development, which will be discussed in this chapter. A number of additional factors will also influence the rate at which solar energy's potential is realized.

For example, the proponents of solar energy, like the proponents of wind energy, urge the establishment of a level playing field in the energy supply business, the internalizing of environmental and social costs of energy production and use, and greater promotion of their option by governments by, for example, setting targets for the contribution of renewable energy to our energy supply.(1) In addition, the potential for reducing pollution by increasing the use of solar power is similar to that of wind energy, since these sources do not produce or release atmospheric pollutants at point of generation.

POTENTIAL CONTRIBUTION TO ENERGY SUPPLY

At present, the contribution of solar energy to Canada's energy supply requirements is minimal. Yet, it is estimated that it could provide between 1 and 5% of all our domestic energy needs, depending on how aggressively the country wanted to pursue this option. In the long run it could provide considerably more.(2)

In his appearance before the Committee, Dr. Raye Thomas, Past President of the Solar Energy Society, quoted from a recent EMR study projecting that by the year 2010, in the absence of any major subsidies, solar photovoltaics (PV) could be providing about 866 megawatts of electrical power in Canada.(3) The Committee was also told that an estimated 30% of the heating requirements for buildings in this country could conceivably be supplied by passive solar energy, with a like amount being potentially provided by active solar.(4) No discussion of the costs involved, or of the institutional barriers, was presented, but this gives an idea of the technical potential for solar energy in these two applications.

If even a small part of this potential could be captured, solar energy could make a contribution to reducing CO_2 emissions. As one of our witnesses pointed out, however, since we are starting essentially from base zero, it is unlikely that solar energy will be able to contribute to the target of stabilizing CO_2 by 2000. Only after that time, perhaps by 2020, will

solar energy be able to contribute significantly. The witness noted further, that solar energy will not make any significant contribution to Canada's future energy needs unless we begin to build up this renewable energy base.(5)

The Committee was informed that, as in the case of wind energy, other countries are taking solar energy much more seriously than we do in Canada. For example, the government of Germany has set a target for 50% of residential electricity to be generated by solar photovoltaic cells by 2030. Japan has a target of 30% and the United States is aiming for 15%. These countries are not saying that this technology is competitive now, but they are investing in something which they see as valuable and cost effective in the future.(6) Of course, one must remember that the energy supply situation in all these countries is quite different from that in Canada with the exception of the U.S.; none of them has our wide range of domestic, conventional sources.

EMERGING TECHNOLOGIES AND COSTS

Canada does not represent a large market for solar energy technology. And, there are very few manufacturers of solar equipment and not a great deal of technological development being undertaken in this country. The federal Department of Energy, Mines and Resources does support a small, focused R&D program which depends on contracted out research.

The current Canadian solar program concentrates on three areas: passive solar energy; photovoltaics; and active solar energy. The current federal budget for contracted-out research in the area of passive solar energy is about $1 million per year. The passive solar program has two major objectives: to support research into new concepts and products so as to allow a greater passive solar contribution to the heating needs of buildings, and to provide information to encourage industry to include passive solar features in building designs.(7)

The Committee heard that some architects are already including such features. Construction costs for a passive solar home are estimated at perhaps 10% more than for a similar home that meets existing building codes.(8) This cost is more than offset by the reduced heating costs achieved from the integration of passive solar features. When buying a house, however, most people are concerned first with price, and only later with operating efficiency. This attitude works against acceptance of new design features that increase costs, but as the Canadian public becomes more familiar with the benefits of solar energy, the industry hopes to achieve a much greater market penetration. As well, government promotion of, and possible "back-stopping" assistance for, energy efficiency mortgages and other similar tools would be helpful. The importance of government support in providing information to builders and to the public is self-evident.

With regard to new concepts and products, the main focus of the Canadian program is improving the energy performance of windows. More than half the passive solar budget is now spent in this area and work is underway in basic research, product development and industry support. In this regard the Committee notes and welcomes the inclusion of passive windows and door systems within the purview of the government's Energy Efficiency and Alternative Energy Act. In addition, about $250,000 is being spent on two demonstration projects that

include the latest energy efficient windows and other solar features. Other passive solar technologies currently being supported include thermal storage, integrated mechanical systems and day-lighting in commercial buildings.(9)

Canada has been involved in photovoltaic research since the 1970s, when university laboratories took the lead. The National Research Council began funding such research under its Solar Energy Program in 1977, with an emphasis on long-range applications. Research was carried out in a number of areas including PV materials, improvements in cell manufacturing processes, and proof-of-concept system trials. The Natural Sciences and Engineering Research Council (NSERC) also funded PV research at the level of about $1 million per year. The National Research Council's entire energy program was eliminated in 1985. NSERC support has continued, but at a somewhat lower level. In 1985, the Department of Energy, Mines and Resources took over responsibility for the program and funding has remained relatively constant since that time.

Canadian funding for PV research is much lower than in a number of other countries (Japan - $40 million, Germany - $100 million, Italy - $40 million). This leaves Canada with little chance of leading in the search for reductions in the cost of PV modules. Recognizing this fact, the Canadian program is geared to the application of the technology rather than its refinement. The program's primary objective is to support the growth of a domestic industry by developing PV products that have near-term market potential in Canada and abroad. For example, we are concentrating on the development of a PV/diesel hybrid system to supply electricity requirements ranging from those of a single residence, to those of a small scientific outpost or a small village. The program also supports product testing, field monitoring, system performance analysis and design and simulation software development. The government will continue to take part in a limited number of proof-of-concept demonstration projects and to a modest degree help with educating the public about this technology and its potential.

The costs of photovoltaic systems continue to drop; in the United States it has been estimated that by the year 2015 or so, the cost will have reached about $2,000 (US) per kilowatt hour installed. This is seen as the "magic figure" at which PV- generated electricity will be directly competitive with other generation technologies even assuming that these other energy sources continue to benefit from current levels of direct or indirect government spending support. This installation cost would result in an electricity price of 12 cents/kWh. Ontario Hydro estimates that at the moment, a PV system operating in Ontario produces electricity at about 50 cents/kWh, with the cost estimated to drop to 16 cents by the year 2000. Given current rising electricity rates in Ontario, PV-generated electricity may become cost-competitive with conventional systems sooner than expected.(10)

In the area of active solar energy, the program is concentrated on just two technologies which are seen as having potential application in Canada over the next 20 years. Those two technologies are residential hot-water heating systems and ventilation air for commercial buildings. The total annual budget for active solar energy now stands at about $700,000, down from about $2.5 million in 1986. Because of the lack of a developed market for active solar technologies in Canada, the small manufacturing capability which we once had in this field has virtually disappeared.(11)

Like wind energy, solar energy is virtually clean at its point of generation. However, (and again, like wind energy) the manufacture and transportation of those technologies and devices required to harvest the energy can involve significant atmospheric (and other biospheric) emissions. Still, the impact of these emissions shrink to insignificance when compared to those of more traditional energy sources. Too, these two forms of energy are truly "renewable" (for the next several billion years, at least); indeed, for our species' practical purposes, they are infinite.

Already, in applications ranging from office building (and building water) heating, to the running of ranchland water pumps, to residential heating, to the powering of emergency phone lines along major urban roadways, solar energy is making inroads into our day-to-day lives. This will only accelerate.

As but one example, Swiss researchers recently announced they had successfully created an industrial prototype for a window that not only acted as a passive solar heat retainer, but that also actually generated electricity from the solar radiation passing through it.

The Committee is of the opinion that, principally for environmental reasons but for other economic and commercial reasons as well, solar energy will be the energy source of choice in the future. The implications for technology development and marketing are little short of revolutionary.

Canadian policy-makers must very quickly decide whether or not they want Canada to be in the forefront of these developments. If so, the significant public investment required to overcome our current lagging status and to propel us to that forefront must be made starting now.

In general terms, and assuming that significant changes are not made to open up opportunities for solar energy to participate in energy supply, solar energy is not expected to provide any significant contribution to Canada's energy mix until well into the next century. The industry would claim that, given its potential contribution to relieving stress on the environment, solar energy ought to be developed more rapidly. Of course, the day when it is cost competitive will come sooner than anticipated, if full-cost accounting ever becomes a reality.

ENDNOTES

(1) Christian Ouellet, President, Solar Energy Society of Canada, *Minutes of Proceedings and Evidence*, House of Commons Standing Committee on Energy, Mines and Resources, Issue #10, 10 December 1991, p. 10:48.

(2) Jeff Passmore, Passmore Associates International, 16 January 1992.

(3) Dr. Raye Thomas, Past President, Solar Energy Society of Canada, *Minutes of Proceedings and Evidence*, House of Commons Standing Committee on Energy, Mines and Resources, 10 December 1991, Issue #10, p. 10:49.

(4) Ouellet (1991), p. 10:49.

(5) Doug Loriman, Director, Solar Energy Society of Canada, *Minutes of Proceedings and Evidence*, House of Commons Standing Committee on Energy, Mines and Resources, Issue #10, 10 December 1991, p. 10:49.

(6) Thomas (1991), p. 10:45.

(7) Department of Energy, Mines and Resources, *Renewable Energy Projects Digest: Passive Solar*, Ottawa, 1989.

(8) Helen Ostrowski, *Minutes of Proceedings and Evidence*, House of Commons Standing Committee on Energy, Mines and Resources, 12 December 1991, Issue #10, p. 10:55.

(9) Energy, Mines and Resources (1989).

(10) Thomas (1991), p. 10:46.

(11) Ouellet (1991), p. 10:39.

CHAPTER 14

HYDROGEN

INTRODUCTION

In the period from 1980 to 1992, at least ten major studies were carried out in Canada to assess the potential for hydrogen on the Canadian and world energy scenes. Even though these studies each had a different focus, all but one of them recommended very strong support for hydrogen development. The only study indicating a more modest approach was conducted by EMR staff in 1989. It is this study that has been adopted as the current federal government position; its program has a technology development component financed at approximately $3 million per year.

The Committee is of the view that the conclusion reached by previous studies, that in the longer term there are Canadian opportunities for hydrogen, remains valid. Furthermore, in moving towards greater integration of hydrogen into our energy system, Canada has advantages in being a very major producer and user of hydrogen, with a world scale production system. In addition to experience in hydrogen production by conventional means, there are two new hydrogen technologies in which Canadian industries have a leading edge on the world scene. The Committee believes that Canada could derive significant benefit in the long term if these two technologies–the fuel cell being developed by Ballard Industries, and the photovoltaic/electrolysis system of Electrolyser Corp.–were commercialized in a timely manner. Even though the Committee is not in the business of picking winners, we recognize that there are times when prompt action is required to cash in on an advantage that Canada enjoys. We therefore feel that the demonstration and commercialization of these technologies should be supported.

CONTRIBUTION TO CANADIAN ENERGY SUPPLY

Although the current, direct contribution of hydrogen to the Canadian energy supply is quite small, its indirect contribution as a component of refinery fuels production and in the upgrading of heavy oils and bitumens is very significant. In this component of the hydrogen industry, Canada has world scale facilities for the production and use of hydrogen. Canadian production of hydrogen is close to two million tonnes per year, of which more than 30% is used by the petroleum sector in the upgrading and refining processes.[1] This use is expanding by about 6% every year and will expand even more rapidly in the future, if we develop more of our vast oil sands resources. The bitumen from the oil sands must be upgraded before refining can take place. This upgrading can be achieved in one of two ways-by removing carbon or by adding hydrogen. Syncrude and Suncor currently use the former method, hence the growing piles of coke near their processing plants. It is expected that, in response to environmental as

well as economic concerns, there will be a gradual shift towards the hydrogen addition method. The hydrogen for this shift will come first from the steam reformation of natural gas or methane (SMR) and later perhaps from coal-bed methane and later still from the conversion of H_2S.[2] The last two approaches would have environmental benefits as they would reduce the release to the atmosphere of the otherwise unused coal-bed methane, and eliminate problems associated with hydrogen sulphide emissions. Hydrogen is thus seen as having an increasingly important input to the upgrading of our fossil-fuel resources, long before it makes any significant contribution as a fuel in its own right.

ENVIRONMENTAL IMPACTS OF PRODUCTION, DISTRIBUTION AND USE

Hydrogen is often promoted as the cleanest of fuels. In its end-use as a fuel this is certainly true. As with all fuels, however, one must look at the entire fuel cycle in assessing its overall environmental impact. Currently, some 90% of Canadian hydrogen is produced by steam methane and naphtha reforming (SMR). Since the process is based on the conversion of a fossil-fuel, its main environmental impact is the production of CO_2.

POTENTIAL FOR POLLUTION REDUCTION

The direct use of hydrogen as a fuel could be extremely beneficial to the environment since essentially the only emission at point-of-use combustion is water vapour. As indicated in the section above, however, the current commercial production of hydrogen by SMR results in the emission of large amounts of CO_2. Electrolysis of water to produce hydrogen would not cause such carbon dioxide emissions, but if the electricity for the electrolysis process were generated using fossil-fuels, CO_2 and other harmful emissions would be created in significant volumes. An overall reduction in atmospheric pollution throughout the fuel cycle would only be achieved if the electrolysis was powered by electricity generated by solar or wind energy. Nuclear and hydro energy, could be used to reduce some of these atmospheric emissions but as seen in other sections of this report, bring their own environmental challenges. Solar and wind energy, coupled with electrolytic hydrogen production, and end-use technologies that could use pure hydrogen, could be said to represent the "ultimate" in environmentally clean energy systems. Clearly such a system is a long way down the road as many technological, economic and institutional barriers are still in the way.

Another approach to reducing the environmental impact of hydrogen production could be to develop an economic means of capturing the CO_2 and reinjecting it to enhance oil recovery, or disposing of it underground or in the ocean. The Alberta Oil Sands Technology Research Authority (AOSTRA) is doing some work on this technology, but again this does not offer a near-term prospect. Despite the research that still needs to be completed, the prospect of a transportation system, for example, in which the hydrogen fuel was produced cleanly and then used to fuel an equally clean fuel cell, is well and worth pursuing.

CURRENT AND EMERGING TECHNOLOGIES AND THEIR COSTS

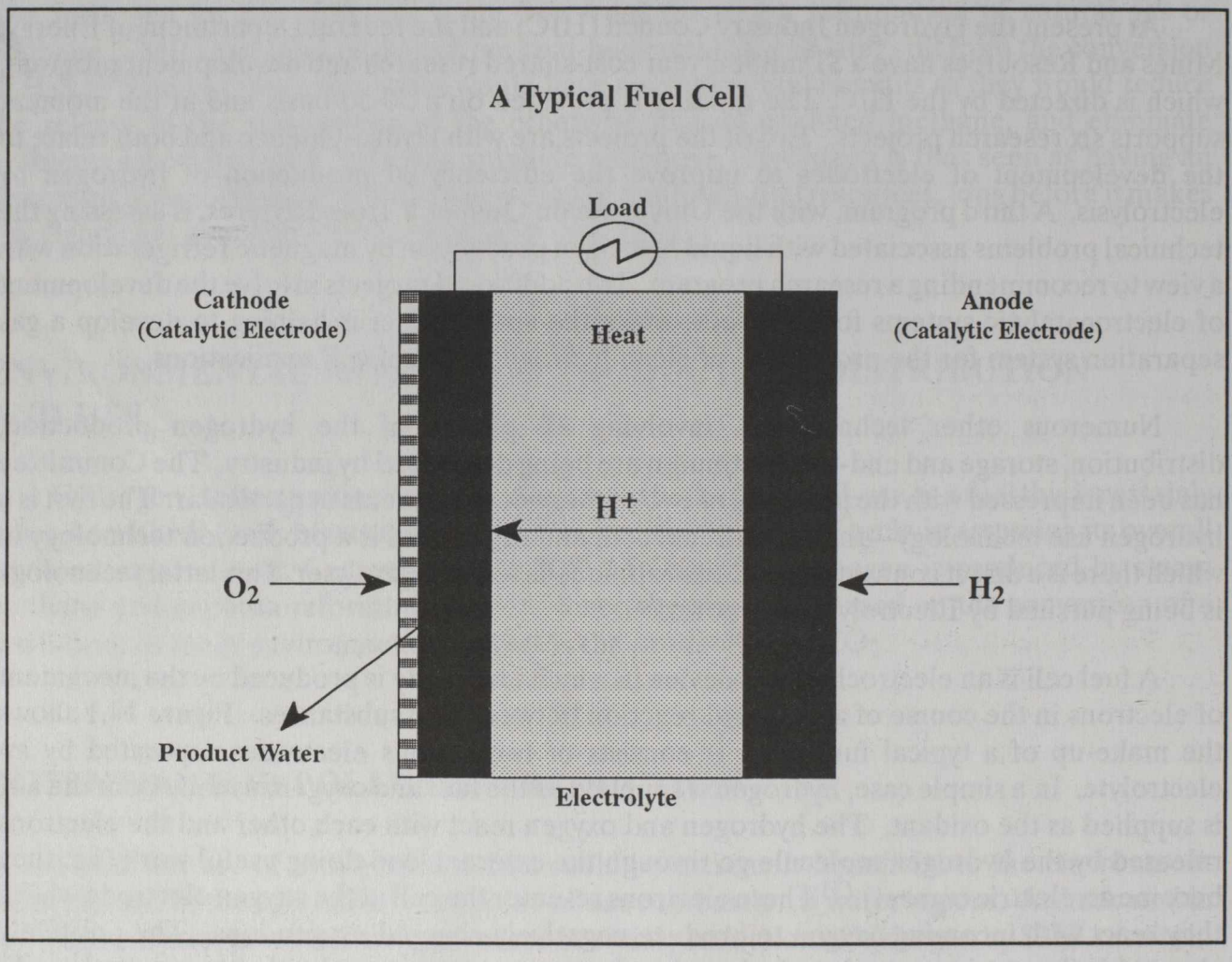
At present the Hydrogen Industry Council (HIC) and the federal Department of Energy, Mines and Resources have a $1 million/year cost-shared research and development program, which is directed by the HIC. The funding is provided on a 50-50 basis and at the moment supports six research projects. Two of the projects are with Hydro-Québec and both relate to the development of electrodes to improve the efficiency of production of hydrogen by electrolysis. A third program, with the Université du Québec à Trois-Rivières, is assessing the technical problems associated with liquid hydrogen production by magnetic refrigeration with a view to recommending a research program. Two additional projects involve the development of electrocatalytic systems for fuel cells, while the sixth project is helping to develop a gas separation system for the production of clean hydrogen for fuel cell applications.

Numerous other technologies, involving all phases of the hydrogen production, distribution, storage and end-use continuum are being developed by industry. The Committee has been impressed with the potential of two of these developments in particular. The first is a hydrogen use technology—the Ballard fuel cell, and the second is a production technology in which there is a direct connection of photovoltaic cells to an electrolyser. This latter technology is being pursued by Electrolyser Corporation.

A fuel cell is an electrochemical device in which electricity is produced by the movement of electrons in the course of a chemical reaction between two substances. Figure 14.1 shows the make-up of a typical fuel cell. It consists of two porous electrodes separated by an electrolyte. In a simple case, hydrogen is supplied as the fuel and oxygen, usually from the air, is supplied as the oxidant. The hydrogen and oxygen react with each other and the electrons released by the hydrogen molecule go through the external load doing useful work (i.e. they become an electric current).[3] These electrons re-enter the cell at the oxygen electrode where they react with incoming oxygen to produce negatively charged oxygen ions. The positively charged hydrogen ions, produced when the electrons were removed, migrate across the cell, react with the oxygen ions and form water as a by-product.

The process just described does not involve any combustion and its only two products are electricity and water. It produces no SO_2 or CO_2, and, because it operates at just 80 degrees Celsius, no nitrogen oxides.[4] Clearly, for applications in automobiles or as a power source located in densely populated areas with high electricity demand, the clean operation of this process would offer distinct environmental advantages, especially to polluted cities. This equation, of course, does not account for any environmental impact from the production of the fuel cell itself, or of the hydrogen, an issue that was discussed above.

FIGURE 14.1



Source: Keith Prater, Ballard Power Systems, Presentation to the Standing Committee on Energy, Mines and Resources, 30 October 1991.

For the electrochemical process to take place, an electrolyte must be present between the two electrodes. In most fuel cells this electrolyte is a corrosive liquid, adding bulk and potential environmental problems. The question of bulk is most important in the automotive application. The Ballard fuel cell addresses this problem by using a solid plastic as the electrolyte, allowing the production of very small, compact, safe fuel cells. This technology is an outgrowth of a General Electric concept developed in the 1960s for NASA, redesigned for terrestrial applications by Ballard, with support from a number of sources including the Department of Energy, Mines and Resources. Whereas the G.E. fuel cell operated on pure hydrogen and oxygen, the Ballard cell is designed to operate efficiently on air and on "dirty" (fossil-derived) hydrogen. Ballard has also greatly reduced both the cost and the size of the fuel cell, making mobile applications a possibility and in the process becoming a world leader in this exciting field.(5)

In his appearance before this Committee, Mr. Keith Prater of Ballard Power Systems outlined the program currently underway in which a 100 kilowatt Ballard fuel cell, just 10 inches by 20 inches, is being installed on a bus in Vancouver, which should be in operation by late 1992.(6) Mr. Prater also told the Committee of his fear that, because of the current structure of federal demonstration programs, this promising technology could be lost to Canada. His company estimates that it will require about $50 million for development over the next five years and probably another $50 million for testing and demonstration. At the time of his appearance the company had raised some $14 million and had about $11 million in funding from the federal government and the British Columbia government. There has been a great deal of interest from Japanese, European and American concerns that want to promote the development of the fuel cell in meeting their national and international commitments to reduce GHG emissions. In fact the U.K. will be focusing its entire $50 million government/industry fuel cell program on the solid polymer electrolyte fuel cell over the next five years; Japan will have a similar amount in its program and the U.S. Department of Energy is proposing to spend $124 million on the technology over ten years.

Unfortunately, private Canadian companies do not seem inclined to accept the risks associated with promoting new, and thus commercially risky, technologies such as this. Mr. Prater fears that "If Ballard were to raise an additional $50 to $100 million in equity, it is extremely unlikely, based on our past experience, that we would be able to avoid becoming foreign controlled."(7) As a small company, Ballard claims it would have a very difficult time even raising the $25 million that would allow it to participate in the federal matching funding program for product development, without accepting majority foreign ownership. This program is seen as perhaps valid for a mature industry, but it does not address the problems of small entrepreneurial companies with innovative technologies ready for the demonstration phase, which is often prohibitively expensive.

The Committee feels that technologies such as that owned by Ballard have the potential to have such a profound impact on the transportation sector that Canada should take all necessary steps to ensure that their development can continue as a product owned and controlled in this country. As countries around the world seek to reduce GHG emissions from their transportation sectors in particular, the market for this technology could be phenomenal. We urge the government to establish programs to allow the domestic commercialization of such innovations.

In promoting the development of a fuel cell such as Ballard's, we are aware that the cell itself represents just one part of the whole system that needs to be developed if a hydrogen-fuelled automobile is to be produced. There will have to be complementary work on the fuel production system (i.e. a small methanol reformer to provide on-board hydrogen production), control systems, and perhaps (should the fuel cell prove to operate better on cleaner hydrogen) on a gas separation technology such as that being funded now by the Hydrogen Industry Council-Energy, Mines and Resources program. Nevertheless, we feel that Canada's technology development efforts in hydrogen would be greatly enhanced by having such a focused and targeted commercial goal.

The Committee was also struck by the long-term potential of Electrolyser Corporation's efforts to connect photovoltaic cells directly to an electrolyser for producing hydrogen. This process has required the design of a system in which the electricity from a photovoltaic cell is

fed directly into a matched electrolyser without the need for the former bulky, costly and inefficient power conditioning equipment.[8] Any time that such a step can be eliminated from the hydrogen production process, efficiency improves and costs drop. As noted before in this section, if hydrogen can be produced economically, from solar energy, then, with the evolution of new end-use technologies such as the fuel cell, we have the basic ingredients for a domestically created and produced energy system that is (except in its manufacture and transportation) virtually pollution-free. The Province of Ontario has helped to fund research in this field and a small unit, considered to be the world's first effective solar-hydrogen generator, is now operating in that province. A larger version of this pilot system will be installed in the near future in Los Angeles under the sponsorship of the South Coast Air Quality Management District. The hydrogen produced will be used to fuel converted internal combustion engines and, later, in fuel cell demonstration vehicles.[9] Already one can see the interest that such technologies generate in other countries. It would clearly be in Canada's best interests to ensure that these technologies are commercialized here. As one of our witnesses noted ". . . the most important ingredients are inspired leadership and adequate funding."[10]

ENDNOTES

(1) W. Yurko, *Minutes of Proceedings and Evidence*, House of Commons Standing Committee on Energy, Mines and Resources, Issue #5, 30 October 1991.

(2) *Ibid.*

(3) Keith Prater, Ballard Power Systems, Presentation to the Standing Committee on Energy, Mines and Resources, 30 October 1991, p. 3.

(4) *Ibid.*

(5) *Ibid.*

(6) *Ibid.*, p. 5.

(7) *Ibid.*, p. 6.

(8) A.K. Stuart, "Hydrogen: Responding to the Clean Energy Challenge," Brief presented to the House of Commons Standing Committee on Energy, Mines and Resources, 30 October 1991, p. 6.

(9) *Ibid.*, p. 7.

(10) *Ibid.*, p. 11.

CHAPTER 15

ENERGY EFFICIENCY AND CONSERVATION

INTRODUCTION

During the 1970s, when oil prices were rising rapidly and there was marked concern over the security of supply of this vital commodity, energy conservation and improved energy efficiency were pursued with some vigour by all sectors in Canadian society. This situation has changed dramatically over the intervening years as has the enthusiasm in some circles for, and the amount of government funding of, energy efficiency and conservation measures. Some progress was still made as industries adopted measures that could save them money and help them to remain competitive. Today, an important driving force behind this energy "sector" is concern for the environment. Virtually every industry witness who appeared before the Committee listed improved energy efficiency and/or conservation as one of the principal components of the strategy for meeting environmental challenges.

The National Energy Conservation Association told the Committee that as energy efficiency and conservation measures are applied in all sectors of our economy for environmental reasons, they will provide benefits in other areas, benefits that may outweigh the environmental improvements that were the initial target.(1) For example, the Association notes that since Canada must become much more aggressive in securing international markets for our products and services, it must minimize the price of energy built into those products and services. Conservation and efficiency improvements will, as always, help accomplish this.

The last 10 years have, in fact, seen significant progress in the state-of-the-art for efficiencies in buildings, lights, appliances and industrial processes. It has been repeatedly demonstrated in jurisdictions around the world that we can produce the same amount of goods and services while using significantly less energy. If we are to achieve sustainable energy and mineral development in this country, clearly conservation and efficiency of energy use will play significant roles. This chapter examines historical trends and the current potential for energy-efficiency improvements in the Canadian economy, and identifies some barriers to realizing that potential.

EFFICIENCY TRENDS IN CANADA

Canada is a relatively high-intensity user of energy. This is generally believed to reflect the vastness and harsh climate of the country, our relatively energy-intensive, resource-based industrial structure, the relative abundance of energy at low prices, and less emphasis on conservation activities than is the case in a number of other industrialized countries.

It is one thing to say that Canadians use energy intensively, compared with other industrialized countries. We find this to be clearly the case when we measure the amount of end-use energy demand per dollar of GDP, with Canada always faring quite poorly in this

comparison. One cannot, however, automatically assume that since we display high intensity of energy use, that we are energy inefficient or wasteful. In fact, the two concepts are quite different, in that while changes in energy intensity may indeed be affected by changes in energy efficiency, they also may reflect other factors, such as changes in industrial structure.

As was alluded to above, the nature of our industrial output differs substantially from that of other countries such as Japan and Germany, whose major industries are much less dependent on energy as an input than our own. This reality will not change as long as we continue to rely extensively for our economic well-being on our abundant natural resources.

Another element which injects a flaw into comparative analyses of energy efficiency performance is the use of a common currency in such measurements, typically the U.S. dollar. The problem occurs when sizeable changes in exchange rates bias the result and render the international comparison for a given year decidedly less than useful. While the problem can be avoided by placing energy use in per capita terms rather than in relation to GDP, energy use per capita is still not an accurate indicator of efficiency.(2)

Energy efficiency can be categorized as the amount of energy required to perform a given task, such as heating a home to a certain temperature, or driving a vehicle 100 kilometres. As we have indicated, as soon as one sums up the individual efficiency calculations into a single measurement, using output in dollars rather than in physical units, or one totals the outputs of a number of industries together, one is capturing more than just the effects of energy efficiency.

Notwithstanding the above points, it is important to realize that the history of energy use in the 20th century in Canada has been one of steady and substantial amelioration; even over the decades of the 1970s and 1980s, energy intensity (energy end-use per dollar of constant $ GDP) improved by one-third, although gains have flattened out in recent years, as energy prices have stabilized or fallen.(3)

Many of these realized improvements in energy intensity reflect shifts in the underlying structure of the economy, away from energy-intensive activities such as heavy industry and towards the service sector and light manufacturing. More than half of the gains in the last 20 years, however, reflect the incorporation of more energy-efficient technologies and behaviour within given sectors of the economy.

Energy-efficiency improvements in the 1970s were supported by major government programs, such as CHIP (home insulation program) and COSP (furnace conversion program). Mandated improvements in the energy efficiency of passenger vehicles, particularly in the United States, also made a significant contribution. At present, the biggest institutional impetus to enhanced energy conservation comes from the electrical, and to a lesser extent, gas utilities. Not only do they have the financial resources and infrastructure to deliver broad-based support to energy-efficiency programs, but, with the rising cost of electricity generation, a number of utilities see that it is more cost effective to invest in what has commonly become known as "negawatts" or conservation measures which save energy, than in the capacity to generate additional "megawatts."

Albeit slowly, some of the regulatory and institutional barriers that have made it difficult for utilities to take this approach have been lowered.

For example, the Committee heard that Edmonton Power has been working to overcome the institutional barriers to using an existing generating station to supply energy for a district heating system, thus conserving a good deal of the energy that would otherwise be lost as waste heat.(4) This project will go ahead as soon as customers are lined up and opposition on Edmonton's city council is overcome.

Additionally, in a number of jurisdictions, utilities and regulators are addressing the accounting and rate-making implications of including utility investments in energy conservation in the "rate base," i.e. putting them on the same basis as investments in generation and transmission capability.

A third example of removing institutional barriers is the growing recognition by electric utilities that they should not be offering to heat houses with electricity.

POTENTIAL CONTRIBUTION OF IMPROVEMENTS IN ENERGY EFFICIENCY

Consideration of the potential contributions to be made by improvements in energy efficiency poses two basic questions:

— What do we mean by "potential contribution?"

— To what should this "potential contribution" be compared, i.e. what is the base case?

One way to define potential is to develop a base case reflecting today's energy use characteristics. In other words: how much can we save in the context of our present use?

Even if we could "freeze" energy efficiency at today's levels, changes in the level and mix of economic activity would imply variations in our projected energy use. Also, some energy-efficiency gains are generational; for example, today's new appliances use energy more efficiently than those purchased 20 years ago. Thus, when the old appliances wear out, and are replaced by new ones, there will be an automatic societal improvement in energy efficiency. Perhaps we should include this enhancement in energy efficiency in our "base case". Similar arguments apply in the transportation sector, and in much of manufacturing; the argument is less applicable to residential and commercial buildings, since these have a considerably slower turnover rate.

Once the base case is defined, we need to determine what potential exists for energy-efficiency improvements. In this regard, it is useful to distinguish the continuum between the two poles of "technical potential" and "market potential."

"Technical potential" pertains to those energy-efficiency improvements which are possible given the current state of technology without regard to economic cost. From this perspective, it is clear that the Canadian economy could operate on a minute fraction of the energy it currently uses. To reach this stage, however, massive investments would have to be made in energy conservation. It is unlikely there would be any immediate prospect of deriving direct economic benefits from these investments.

"Market potential," on the other hand, refers to those energy-efficiency improvements that would come about merely in response to market forces (once existing market disincentives to energy efficiency were removed) independent of any intervention by governments. By definition, these improvements would entail direct economic benefits. It is widely acknowledged, however, that market forces alone may only result in modest energy-efficiency improvements.

Determining the true potential for energy-efficiency improvements thus is not a straightforward task. It necessarily entails consideration of what can only be called a political decision—what is deemed to be "reasonable." For example, some efficiency improvements will pay for themselves almost immediately, while others will never save money even though they may be worth making for social reasons. The pursuit of still other energy-efficiency improvements, while possibly reducing energy use marginally, would be prohibitively expensive so as to result in a net detriment to society.

Naturally, this Committee is most interested in knowing initially the potential for energy-efficiency improvements that are economically attractive in the near future, and those which will result in the greatest environmental benefit. Even this determination is difficult to make, however, because there is remarkably little information available to allow quantification of even the economic costs and benefits of such efficiency improvements. The little information that is available barely allows us to examine the potential savings in individual sectors of the Canadian economy within the current regulatory framework and market conditions.

Other chapters of this report have looked at the various industries in the energy and mining sectors. While there is an oil and gas industry, save for the important and proliferating consulting and engineering firms specializing in the implementation of energy efficiency strategies, there is no "energy efficiency industry" per se. There are many products and services that enhance energy efficiency. By and large, however, an energy-efficient refrigerator is made by the same manufacturers that make less efficient refrigerators and generally with components from the same suppliers. They have probably designed them with the same design staff, although with different design parameters. There is no energy-efficiency refrigerator industry distinct from the refrigerator manufacturing industry itself. Consequently, a discussion of the conservation industry's response to the environmental challenge is really a discussion of what factors will influence the energy-using sectors to take up energy-efficiency technologies.

A. The Residential Sector

The residential housing sector is responsible for about 20% of energy end-use in Canada. Because houses are such long-lived assets, most of the potential for energy-efficiency improvements in this sector over the next 10 years is to be found in the existing stock.

The Committee heard from the Canadian Home Builders' Association,[5] which identified a number of areas for action on energy conservation. These include:

— An improvement in energy-efficient building envelopes, through enhanced training and standard setting, and a stated desire to seek to extend the successful R-2000 Program from new houses to retrofit housing.

— Improvements in heating, ventilation, and cooling systems, particularly the incorporation of mid and high-efficiency furnaces, heat pumps where cooling capacity is required, heat recovery ventilators to capture waste heat being exhausted to the outside air, etc.

— Energy-efficient windows, reflecting the improvements in window technology in the last decade, including double-glazed, triple-glazed and low emissivity-coated windows with significantly increased R-values.

— Energy-efficient appliances encouraged through an update to the Energuide Program, and the setting of minimum energy efficiency standards.

— Energy-efficient lighting, particularly reflecting recent developments, such as compact fluorescent bulbs, and the recently announced radiowave-stimulated light bulb.

Some studies have explored the magnitude of potential savings in more detail.(6) It appears that substantial savings in single family homes are to be found in more efficient refrigerator design, more efficient lighting, retrofitting uninsulated homes in most parts of Canada, and upgrading to higher efficiency furnaces, such as the natural gas furnace referred to in Chapter 7, which operates at over 90% efficiency. The savings potential in existing apartments is more difficult to analyze, but the larger savings appear to be achievable through reducing air infiltration by upgrading windows and the outside skin of the buildings, and by upgrading heating systems.

B. The Commercial Sector

The Committee did not hear submissions dealing directly with the commercial sector, which is responsible for about 15% of energy use in Canada. Energy analysts have found it particularly difficult to estimate the potential for energy efficiency in this sector because of the lack of detailed information on energy uses.

Much of the energy in the commercial sector is used in lighting and conditioning the space inside buildings. Generally speaking, space heating is the most important energy use, although lighting is the largest single user of electricity in most building types.

Institutional factors in the commercial building sector significantly impede increased energy efficiency. One of the most important is the split incentive created by the existence of the three distinct roles of developer, owner, and tenant. Although the tenant typically pays energy costs in the end, the tenant does not have input into owners' and developers' decisions affecting the overall energy efficiency of the building.

C. The Transportation Sector

The transportation sector, particularly passenger vehicles, uses about one-third of Canada's energy. To date, the impetus for enhancing the fuel efficiency of the vehicle fleet in this country has come largely from international forces, with Canada following the U.S.

nationally-mandated fleet efficiency standards. Canadian compliance is on a voluntary basis, with no legislation in force to require automobile manufacturers to meet the prescribed standards. Historically, compliance has not been a problem given the highly integrated nature of the North American auto trade. During the 1970s new motor vehicle fuel efficiency improved rapidly, but the rate of improvement slowed in the 1980s and, in fact, has reversed itself modestly in more recent years.

The Committee would like to see all possible action taken in this country to again reverse the trend and start back on the road to improved fuel efficiency. The challenge for Canada is to find ways to play a leading role in ensuring the improvement in standards, as California is doing in the United States, while at the same time recognizing the reality of the continental nature of the auto industry. In our view, Canadians should not be afraid of meeting this challenge.

D. The Industrial Sector

The industrial sector, like the transportation sector, is responsible for about one-third of Canadian energy use. It is also difficult to assess the potential in this sector, partly because aggregate energy use is highly dependent on changes in the structure of the industrial economy. Houses, office buildings, and automobiles remain relatively similar over time but the mix of output and production processes used in industries can change dramatically in a decade or two.

Many of the energy-efficiency technologies that can be applied to the industrial sector are generic, in that they can be used in most industry. Technologies identified as offering the most potential in the industrial sector include the following:

— Efficient drive power: including: replacement of standard motors with high efficiency motors; adding variable frequency drives to fixed-speed motors; and improving the efficiency of driven equipment. Motive electricity counts for about 75% of industrial electricity consumption. Specific case studies in a recent EMR study suggest that readily available drive power savings in the forest industry are in the order of 21% and in the iron and steel industry 15%.[7]

— Efficient lighting: lighting is the second highest electricity end-use in industry. Because industrial lighting tends to be used more than commercial lighting, all the technologies that are economically attractive in commercial buildings are also attractive in industry.

— Improved combustion efficiency in raising steam and providing direct heat: while the combustion efficiency of boilers and hot air furnaces used in industry has improved steadily over recent years, additional improvements of perhaps 20% are possible.

— Heat recovery and heat pumping, including the use of "pinch" technology to identify optimum heat exchange: in many industries there are opportunities to recover waste heat from one process stream, or from stack gases, and use it to heat other streams. A recent innovation has been the development of "pinch" technology, a computerized optimization process for selecting the most economically attractive location and size of heat recovery and heat pumping equipment at a given fuel price.

— Cogeneration within industry to reduce purchased electricity is a substantial opportunity: this is particularly appropriate given the current relationship between natural gas and electricity prices.

"District heating" (or combined heat and power of the sort being proposed by Edmonton Power) which captures what would otherwise be waste heat produced to power steam turbine electricity generation and circulates that heat for air heating and cooling in surrounding commercial and industrial buildings.

BARRIERS TO ACHIEVING POTENTIAL

The following factors have frequently been identified as inhibiting an appropriate level of investment (i.e. the best level from an overall social perspective) in energy efficiency.

— The gap between the perspective of private decision-makers, and the value of their activities to society: the fact that private decision-makers do not directly bear the environmental costs of energy use is one reason for this gap. In other words, homeowners deciding to invest in a more energy-efficient furnace can identify the resulting savings in fuel costs; however, as they do not receive any direct benefit from the reduced environmental impacts, they do not incorporate this perspective into the decision.

— Information barriers (i.e. insufficient information) either make investors unaware of opportunities for energy-related investments, or increase their perceived risks.

— Financing availability barriers prevent the business sector particularly from investing in energy-efficient capital projects.

— Energy is not perceived as a high priority consideration so that in evaluating energy efficiency investments, decision-makers apply more stringent standards than they do for other investments.

— Government subsidies skewed toward energy supply (i.e. the oil and nuclear sectors) and away from conservation prevents the allocation of resources to conservation and efficiency strategies.

— Indirect subsidies such as funding for highway construction which spurs highway development, encourages people to drive. This makes rapid transit systems less economical to operate, and encourages people to live farther away from their place of work.

— Environmental issues have traditionally been considered economic "externalities". This has the effect of loading the dice against energy efficiency.

Although some of these barriers are typical of technologies and types of investment in their early stages of development, we should not be misled by this; many of the most important and helpful energy-efficiency technologies are well-developed, well-established and fairly

simple to incorporate into current commercial and industrial plant. That they have not been the subject of far greater implementation and general enthusiasm has more to do with short return on investment horizons than it does with any intrinsic problem with the technology and its effectiveness. It is generally agreed that since energy became a concern in the 1970s, information flows have increased, the technical knowledge infrastructure has broadened, demonstration projects are generally in place, and the impact of these barriers has diminished. While a number of witnesses argued for more investment in demonstration projects, this may reflect the industries' concerns about their economic viability during the transition to a period when energy conservation decisions may reflect the social costs of energy use as well as market prices. On the other hand, it is clear that in the last few years, energy efficiency has fallen low on the list of priorities for making investments, in both the public and private sectors.

On the other hand, it has become apparent to a number of major electricity generating utilities that, even without internalizing environmental costs, it is more cost-effective to persuade customers to reduce electricity consumption than to build a new generating facility to meet increased demands—to produce "negawatts," in other words. This realization has led these utilities to emphasize the conservation of electrical energy and, to a lesser extent, natural gas energy. Ontario Hydro and B.C. Hydro are two examples of utilities that have committed themselves to spending hundreds of millions of dollars in energy conservation measures. These range from promotions of compact fluorescent light bulbs for residential customers, through financial support for the purchase of high efficiency motors, to support for gas cogeneration projects to reduce the need for further investments in generation and transmission.

ENDNOTES

(1) Natural Energy Conservation Association, "Facing the Environmental Challenge," Brief presented to House of Commons Standing Committee on Energy, Mines and Resources, November 1991, p. ii.

(2) For a detailed discussion of the difficulties associated with making country-to-country comparisons of energy use/GDP ratios, see Michele McLachlan and Imad Itani, *International Comparisons: Interpreting the Energy/GDP Ratio*, Canadian Energy Research Institute, Study No. 41, December 1991.

(3) Marbek Resources Consultants Inc., "Energy in Canada, 1973-1987: A Retrospective Analysis," Prepared for Department of Energy, Mines and Resources, March 1989, Figure 7.

(4) Stan Gent, Project Manager, District Energy, Edmonton Power, *Minutes of Proceedings and Evidence*, House of Commons Standing Committee on Energy, Mines and Resources, Issue #10, 12 December 1991, p. 10:67-10:76.

(5) Robert Shoat, Canadian Home Builders' Association, *Minutes of Proceedings and Evidence*, House of Commons Committee on Energy, Mines and Resources, Issue #10, 10 December 1991, p. 10:61.

(6) Peat, Marwick, Stevenson and Kellogg, *Economically Attractive Potential for Energy Efficiency Gains in Canada*, prepared for Department of Energy, Mines and Resources, May 1991.

(7) *Ibid.*

CHAPTER 16

TOWARDS AN IMPROVEMENT IN FEDERAL ENVIRONMENTAL POLICY

THE ENVIRONMENTAL POLICY FRAMEWORK

In December 1990, the federal government made public the scope and content of its commitment to the concept of sustainable development by releasing a comprehensive inventory of environmental initiatives as the Green Plan. This document consists of a detailed set of policies and approaches to current environmental challenges. Several witnesses before this Committee noted that of the 309 environmental initiatives included in the Green Plan, over 100 would affect the energy sector in some way.

The Green Plan identifies the major environmental challenges faced by the energy and mineral sectors: global warming, acid rain, ground-level ozone and other noxious chemicals and the control and management of toxic materials. On the complex question of global climate change, the federal government reaffirmed its desired goal to stabilize at 1990 levels all emissions of CO_2, and other greenhouse gases not controlled under the Montreal Protocol (CFCs), by the year 2000. A National Action Strategy (NAS) on global warming has subsequently been developed by the federal government, in conjunction with the provincial and territorial governments. The aim of the NAS is for governments and industry to develop appropriate responses to the GHG emissions challenge based on extensive consultations. The plan will consider each of the principal sources and types of greenhouse gas, as well as all new potential sinks for them, if any.

To improve the scientific understanding of the issue, the federal government will establish a comprehensive inventory and reporting system for greenhouse gases and noticeably increase its scientific study of climate change, particularly in the areas of modelling and monitoring. To help achieve the stabilization goal, the various governments in Canada will be encouraged to develop their own programs complementary to such federal government programs as the initiatives on energy efficiency and alternative energy. These programs will be coordinated by the federal authorities. Measures will also be implemented to assist the public to prepare for the effects of any climatic changes that do occur. The above are viewed as simultaneous first steps towards achieving the stabilization goal and preparing for the consequences of global climate change, and are designed not to impose onerous costs on industry. A number of supplementary initiatives have been identified, which could be implemented in the longer term: use of economic instruments such as an emissions trading program; regulatory/ institutional changes affecting the utilities; and inducing changes in lifestyles.

Commitments have also been made with respect to SO_2 emissions and acid rain, traditionally a dominant issue for the minerals industry, and to a lesser extent, the energy sector. Under the 1985 International SO_2 Protocol, Canada pledged itself to reduce its

emissions by 30% from 1980 levels by 1994. In consultation with a number of provinces, the federal government subsequently announced plans for even deeper cuts in emissions. The Canadian Acid Rain Control Program, the outcome of these consultations, comprises a series of federal-provincial agreements involving the seven provinces east of Saskatchewan, and has resulted in the development of individual abatement programs in each of these provinces. The objective of the program is to lower SO_2 emissions by 50% from 1980 levels by 1994. The Canada-United States Air Quality Accord ties both countries to the 50% reduction target from 1980; the United States is expected to attain the target by the year 2000.

Industry has had to live with these commitments for some time. Western hydrocarbon producing interests have been particularly critical of a new development in the Green Plan. The federal government is undertaking to make the current acid rain control strategy permanent, with its primary vehicle being the establishment of a nationwide SO_2 cap of 3.2 million tonnes by the year 2000. The government intends to have completed its negotiations with all Canadian provinces on this cap by 1994, when industry assumes that specific provincial and territorial levels will have been established. As has already been noted, the extension of the existing control program to the prairie regions of Western Canada, large parts of which are characterized by many low sulphur content fossil fuel sources and alkaline soils, has met with substantial opposition from representatives of that region.

International agreements have also been a key feature of the Canadian response to the NO_x/VOCs issue. Canada is bound by the 1988 NO_x Protocol, to reduce emissions of that smog-inducing pollutant. In addition, a draft VOC Protocol has been prepared for signature. The domestic response has taken the form of the Draft NO_x/VOCs Management Plan, approved in principle by the Canadian Council of Ministers of the Environment (CCME). The target of the Plan, a concentration of ground-level ozone of no more than 82 parts per billion per hour by the year 2005, has been set for all regions of the country. Realization of this target would result in a 40% reduction in emissions in the problem regions of the lower Fraser Valley and the Quebec-Windsor Corridor. The target is, reportedly, already being met in most other areas of the country. The Canada/U.S. Transboundary Air Quality Agreement signed in March 1991 codifies Canada's NO_x commitments under the Management Plan.

This Plan has three phases. The first establishes interim (1995-2000) targets for both types of emissions and contains a set of potential initiatives designed to attain the Plan's objective. Flexibility is built into the system by permitting "environmentally equivalent" least-cost solutions (eg. emissions trading).

Final emissions targets for 2000 and 2005 will be released during the Second Phase of the Plan (1994), together with an identification of additional initiatives required to reach the new targets. The Third Phase, to go into effect in 1997, will provide an opportunity for final adjustments to the 2005 targets and control programs.

The dominant environmental problem for the minerals industry, after SO_2 emissions, is acidic mine drainage. In order to produce permanent and economically viable solutions federal and provincial governments have established with industry a five-year joint research program called the Mine Environment Neutral Drainage (MEND) program, whose total cost over the five years, funded equally by the three participating parties, will be $12.5 million.

Other items on the environmental agenda of the Canadian minerals industry are land access, use, and reclamation, tougher liquid effluent regulations, and the health effects of certain metals.

THE NEED FOR GUIDING PRINCIPLES

The industry groups that appeared before the Committee were generally fully supportive of Canada's commitment to sustainable development, and of the federal government's role in addressing major environmental concerns. Yet there was widespread consensus within the industries that could be greatly affected by the Green Plan, namely, the conventional energy and mining industries, that the environmental plan was fundamentally flawed. The submission from the Coal Association of Canada sums up industry's concerns:

> The fundamental problem is that the plan contains a long list of possible environmental initiatives but does not provide a workable process that would integrate the environmental agenda with an economic strategy and with the ability of industry to respond in a timely fashion. Industry has limited resources and such resources must be allocated to priority issues. Therefore the plan is not consistent with sustainable development or with its own stated principles for environmental action. The economy and its future needs are virtually unmentioned in the detailed descriptions of goals and actions contained in Section 2 of the Green Plan.(1)

There is no question that the Green Plan's coverage is broad, and that the environmental agenda is crowded. The Committee agrees wholeheartedly with the Coal Association's assertion that an economic strategy is of fundamental importance, and that its integration with a progressive and forward-looking environmental agenda is crucial. It is for these reasons the Committee agrees that an improved process of implementation is required, one which will take long-term economic necessities into consideration and thus stimulate a workable, yet effective, response from industry.

Several witnesses (Imperial Oil, Coal Association of Canada, Independent Petroleum Association of Canada) called for the federal government to adopt a set of guiding principles that would prompt a cost-effective response to environmental challenges. These would give some order to the long list of environmental initiatives and assign economic impacts to various environmental policy measures, and thus help industry plan its response effectively. To assist in these endeavours, and the implementation of the Green Plan, many witnesses suggested that an improved decision-making process would be useful.

We support the industry's desire to inject greater clarity into the implementation of environmental policy. The energy and mineral sectors need to work with environmental groups and governments in formulating scientifically sound, cost-effective solutions. A set of principles would, we feel, be useful in guiding the implementation phase in ways which take economic considerations into account. We therefore recommend:

Recommendation no. 1

That the federal government adopt the following set of principles governing environmental policy formulation and implementation. These would specify that, as a minimum,

(a) **All stakeholders, including environmental groups, should be consulted in an effective manner, both when establishing environmental objectives and when formulating policies and action plans (cooperation among stakeholders is of fundamental importance to sound policy-making);**

(b) **Implementation of responses to environmental challenges should be priorized according to the relative scale and urgency of the challenge posed;**

(c) **Action to meet environmental challenges should be based on a scientific understanding of the issue in question;**

(d) **Environmental and economic priorities should be integrated, through an assessment of the total costs and benefits (both economic and social) of potential environmental policy and including assessing the consequences of not implementing such policy;**

(e) **Environmental regulation and legislation should be harmonized across Canada, and improved where possible;**

(f) **While the full array of fiscal and regulatory policy instruments available to governments should be kept in mind when determining appropriate responses to both single and clustered environmental challenges, market forces should be relied upon to the extent possible. (This will provide industry with greater flexibility with which to develop cost-effective responses to environmental problems.);**

(g) **Before negotiating international agreements on the environment, the federal government should consult with stakeholders to ensure that due consideration is given to the maintenance and enhancement of Canadian industry's international competitiveness.**

The sections that follow devote close attention to each of the above considerations and present our views on the need for special action for the various alternative energy options as well as energy efficiency and conservation. The report ends with specific comments on mining, R&D, and the export of technology.

NEED FOR AN IMPROVED DECISION-MAKING PROCESS

In the federal government's implementation of environmental policy, industry would first like to see the establishment of a decision-making process in which more effective dialogue could take place between industry and government. It was argued repeatedly that decision-making based on full consultation with all of the major stakeholders and on the building of consensus would provide important advantages, at a time when industry's financial resources are limited. The Committee agrees wholeheartedly with this assessment. Cooperation between stakeholders is the most important element in fashioning a coherent, rational environmental policy for Canadians. To this end, the Committee believes environmental groups should be included in any such refurbished decision-making process.

The Committee heard criticism of federal actions that were taken without full consultation with the industries directly affected. Notable among these were the decision to stabilize greenhouse gas emissions at 1990 levels, the pledge to impose a nationwide SO_2 cap and the implementation of the NO_x/VOCs Management Plan. In the opinion of industry representatives appearing before the Committee, commitments have been made, both domestically and internationally, without sound knowledge of the magnitude of the environmental problem or of what was realistically attainable. What was deemed to be a preferable approach was used with the revisions to NO_x-emission forecasts, made after stakeholders had been invited to participate in problem-solving. In this case, canvassing the views of industry substantially reduced the expected magnitude of the problem.(2)

The industry groups that appeared before the Committee generally supported the overall objectives of environmental policy, and claimed to be committed to environmental action. They also expressed the hope that through effective consultation, a more realistic environmental strategy would be developed and stressed that a full discussion of the alternative approaches to resolving any given issue should take place prior to the imposition of such a strategy.

The need for establishing priorities among the many environmental concerns identified in the Green Plan was reiterated throughout the hearings. It was pointed out that when financial resources are scarce, they must be allocated rationally and that an improved decision-making process could be invaluable in differentiating between urgent, emerging, and negligible environmental problems. Given industry's wide knowledge of its products and production processes, and its experience with its own environmental protection initiatives, witnesses argued that industry is qualified to advise on the validity of the concerns in question. It was also felt that industry was often in the best position to identify realistic, least-cost environmental strategies.

A comprehensive strategy arrived at through effective consultation could have the added advantage of providing solutions to more than one environmental problem. For example, since SO_2, NO_x, VOCs and CO_2 emissions are all key products of fossil fuel combustion, it is important that they not be viewed in isolation and that priority be given to solutions that can address more than one problem.

Finally, and most importantly, it was argued that a more effective consultation that includes industry and environmental groups could result in improved calculations of the costs and the benefits of environmental policy. For sustainable development, such policy, it was noted, needs to be more closely integrated with economic assessments. The process envisaged by industry could help ensure that the changes required are affordable, so as not to jeopardize the economic survival of our natural resource industries. As we have mentioned, Canada's resource industries' competitive position and financial outlook are in a fragile state at present so their near-term ability to respond to environmental challenges out of current revenues is reduced. It is more important than ever to link environmental goals with the economic capacity to achieve them, as well as opportunities which may arise from their achievement.

Several of the witnesses pointed to the Clean Air Strategy for Alberta (CASA) as an appropriate model for joint decision-making. This is a Government of Alberta initiative, jointly managed by the Departments of Environment and Energy. The Coal Association of Canada calls it a unique process that could be applied to all of today's environmental problems and that captures most of the best features of existing consultative processes.(3)

One of CASA's key features is a special management process developed by the CPA, and illustrated in Figure 16.1. It has a flexible, sequential, decision-making framework and is designed to be "ongoing and cause stakeholders to re-evaluate issues, priorities and decisions as new knowledge becomes available and environmental challenges change."(4)

The CASA process resulted in the submission of a report to the Alberta Cabinet on a recommended strategy to improve the province's air quality. Its recommendations were made jointly by a 13-member committee made up of representatives from petroleum and coal companies, the utilities, authorities in the health field, government agencies and environmental groups.

Undoubtedly, attempting to establish a CASA-type process at the national level will be substantially more difficult, given the intricate regional and sectoral peculiarities of Canadian energy activity, and the jurisdictional problems implicit in a federalist state. These problems must be worked out at an early stage, and responsibilities assigned to the various participating stakeholders. While this challenge will be great, we have become convinced that the effort is well worth the short-term cost. We therefore recommend:

Recommendation no. 2

That the federal government establish ongoing processes of multi-stakeholder consultative decision-making to assign priority to the environmental issues identified; to anticipate problems accompanying the implementation of proposed environmental programs; and to arrive at realistic solutions including clear targets and timetables to properly specified environmental problems.

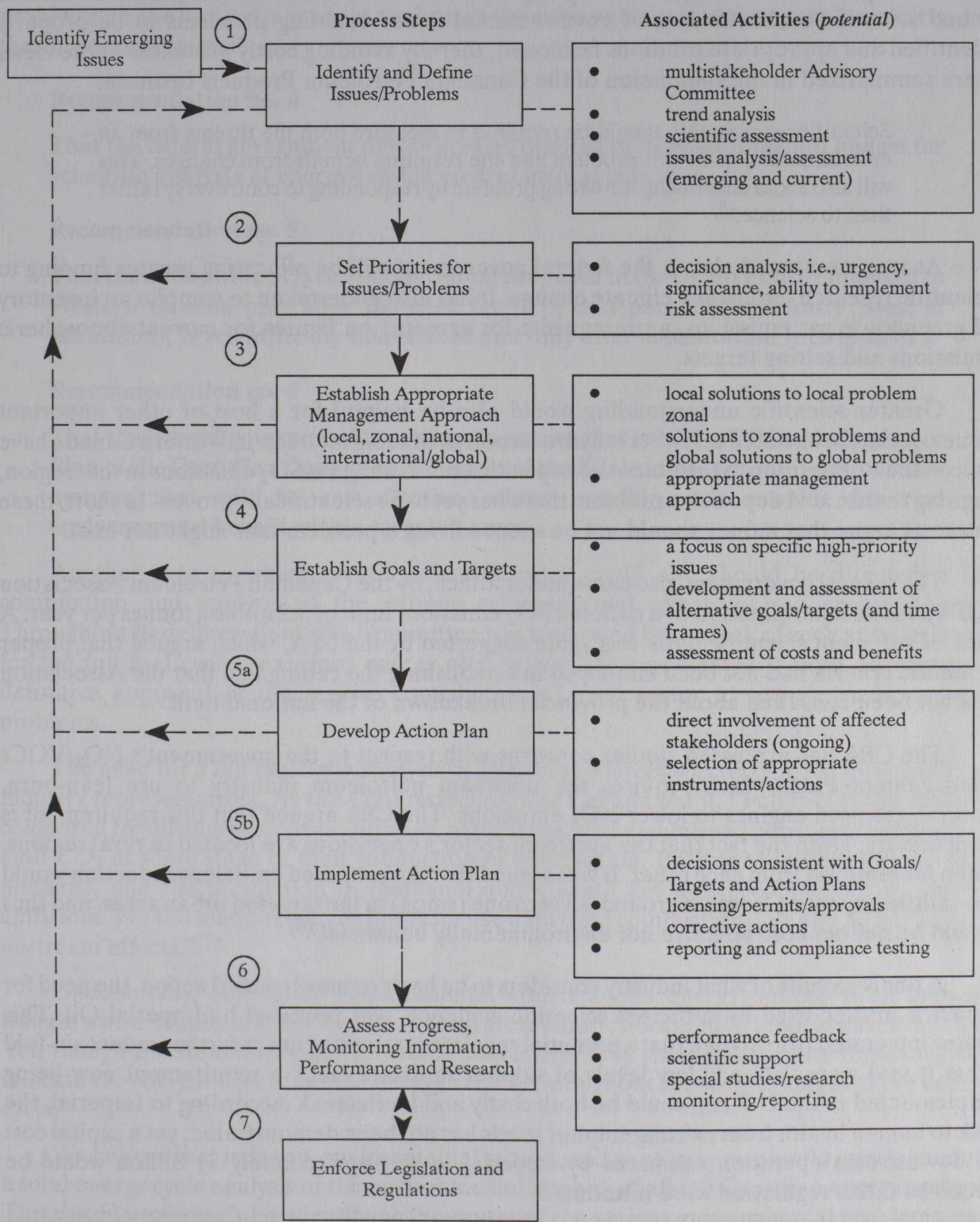
Recommendation no. 3

That the federal government examine the process used to develop the Clean Air Strategy for Alberta as a model for improved decision-making.

It was also brought to our attention that there is an urgent need for federal government departments to communicate more fully with each other on the environmental and economic impacts and inevitable trade-offs of various environmental policy commitments. In the past, it would appear that one department, Environment Canada, has committed the country to certain targets after only limited input from line departments such as Energy, Mines and Resources. While we are encouraged by the Green Plan's commitment to integrate the environmental and economic considerations at all levels of government, the extent and consistency of the criticism on this subject leads us to conclude that more needs to be done at the federal level. We therefore urge the federal government to adopt a more consultative internal decision-making process that will gather together the views of all affected federal departments.

Figure 16.1

A COMPREHENSIVE SYSTEM FOR ACHIEVING ENVIRONMENTAL SUSTAINABILITY



Source: Canadian Petroleum Association, "The Canadian Petroleum Association's Response to Current and Future Environmental Challenges," Submission to the House of Commons Standing Committee on Energy, Mines and Resources, October 1991, p. 8.

THE NEED FOR SOUND SCIENCE

Throughout the hearings, industry expressed its worry concerning a perceived lack of sound scientific understanding of environmental issues enabling problems to be properly identified and appropriate solutions fashioned, thereby avoiding costly mistakes. These views were summarized in the submission of the Canadian Petroleum Products Institute:

> Scientific assessments should be required to measure both the threats from an environmental or health problem and the resulting benefit from changes. This will also avoid addressing the wrong problem by responding to controversy rather than to science.(5)

As was mentioned above, the federal government will be allocating greater funding to scientific research into global climate change. It has also undertaken to compile an inventory of greenhouse gas emissions, a prerequisite for agreeing on figures for current atmospheric emissions and setting targets.

Greater scientific understanding would also be helpful for a host of other important issues. As has been noted elsewhere, hydrocarbon producing interests in Western Canada have voiced their opposition to the potential imposition of a ceiling for SO_2 emissions in that region, arguing that an acid deposition problem there has yet to be scientifically proven. In short, these interests argue that money should not be spent solving a problem that might not exist.

The federal government also came under attack, by the Canadian Petroleum Association (CPA), for its determination of a national SO_2 emissions limit of 3.2 million tonnes per year. A lack of sufficient scientific basis was again suggested by the CPA, which argued that proper scientific criteria had not been employed in establishing the ceiling and that the Association has not been consulted about the provincial breakdown of the national limit.

The CPA has expressed similar concerns with respect to the government's NO_x/VOCs Management Plan, which requires the upstream petroleum industry to use lean-burn, natural-gas-fired engines to lower NO_x emissions. The CPA argued that this requirement is unnecessary, given the fact that the upstream sector's operations are located in rural regions, often far removed from each other. It was argued that the proposed emissions reduction would exert little impact on levels of ground-level ozone (smog) in the targeted urban areas, and thus would be neither cost-effective nor environmentally beneficial.(6)

A final example of what industry considers to be hasty or unwarranted action, the need for which is unsupported by sufficient scientific evidence, was provided by Imperial Oil. This major integrated firm argued that a potential regulatory requirement to further reduce six-fold what it said were "already low levels of sulphur in diesel fuel," a requirement now being implemented in the U.S.A., would be both costly and ineffectual. According to Imperial, the risk to human health from existing sulphur levels has not been demonstrated; yet a capital cost to downstream operation estimated by Imperial to be approximately $1 billion would be required if this regulation were introduced.

We are not suggesting that the implementation of all environmental initiatives be delayed until we have absolute scientific certainty. Yet we are conscious of the need for a thorough assessment of each environmental issue, and assignment of priorities to environmental problems on the basis of a prudent analysis of the relative risks that they pose for society. We therefore recommend:

Recommendation no. 4

That the federal government devote greater funding to its environmental budget for scientific analysis of energy-related environmental concerns.

Recommendation no. 5

That the nationwide SO_2 emissions ceiling proposed in the Green Plan be imposed in Western Canada only after the need for it in that part of the country (west of Manitoba), is scientifically established and only after consultation with industry.

Recommendation no. 6

That the federal government take steps to ensure that the NO_x/VOCs Management Plan of the Canadian Council of Ministers of the Environment be implemented in a manner that will be cost-effective, where possible, and provide for real environmental benefit within targeted areas.

Another area to which greater scientific work could and should be directed is the compilation and analysis of the various environmental effects of the energy options. Throughout its deliberations, the Committee was frustrated by the lack of such an assessment for the full fuel cycle of various energy alternatives. This prevented it from attempting a definitive appraisal of the precise contribution of each sector to today's environmental problems.

The need for a full fuel cycle analysis of all energy sources was recognized by virtually all industry representatives. As the Coal Association of Canada put it, "Full fuel cycles must be compared for all energy sources. Nuclear, natural gas, coal and refined petroleum products all emit CO_2 at some stage of their production or combustion. Both coal and natural gas emit methane, and the production of methanol and ethanol are also accompanied by certain emissions. Far too many of our comparisons use data from combustion only and do not include upstream effects."(7)

Undoubtedly, comparing environmental effects across energy options is an exercise fraught with difficulty and one for which accurate scientific information is not always available. Yet, though the results may not be totally conclusive, they should illuminate the issues and indicate the comparative effects of energy activity throughout the various stages of the energy cycle.

We believe that industry, environmental groups, and governments should jointly conduct a total energy cycle analysis of the environmental impacts of all the Canadian energy options. This would prove useful in identifying the causes of the various environmental problems, and in formulating studies to measure the environmental and social costs and benefits of various energy sources. The Committee thus recommends:

Recommendation no. 7

That the federal government, in conjunction with environmental groups and all the major stakeholders in the energy and mineral sectors, and with the co-operation of the provincial and territorial governments, undertake a full energy cycle analysis of environmental impacts of the various energy sectors.

Recommendation no. 8

That the coverage of this study extend to all stages of the energy cycle for all energy sources, both conventional and alternative.

THE NEED FOR ONGOING ASSESSMENT OF THE COSTS AND BENEFITS OF ENVIRONMENTAL POLICY INITIATIVES

In examining what the concept of sustainable development means for the energy and mineral industries, we have concluded that the economic implications of environmental action should be given as much consideration as the need for environmental improvement. The impacts of environmental action on the economic position of various industries and on the domestic economy in general have tended to be overlooked.

The Committee's intention when launching this study was to obtain industries' appraisals of the costs of certain planned environmental measures and of their economic impacts on their own operations. This appraisal has proven extremely difficult to obtain. Where information of this type has been assembled and thereafter made publicly available by industry, companies or associations, it is usually rudimentary at best. Work is only now being undertaken within the Department of Industry, Science and Technology to estimate the cost of responding to and complying with the many measures announced in the Green Plan. Similarly, no company or department, to the Committee's knowledge, has undertaken any assessment of probable benefits in increased efficiencies and increased exports reasonably to be anticipated in the wake of Green Plan initiatives.

We understand that quantifying the costs and benefits of environmental policy is a complex undertaking. Yet it is essential for the formulation of a realistic response to current environmental challenges and for sustainable development to become a reality. We noted the concept, put forward by the Independent Petroleum Association of Canada, of an "Economic Impact Assessment" (EIA), partially analogous to the more commonly known environmental impact assessments now required of large-scale natural resource development projects.[8] This analysis would be required whenever a new regulatory initiative was launched. Of course, to be complete, any such impact analysis of proposed regulatory initiatives would have to consider both the economic costs of compliance to the industry, and the potential benefits of new opportunities for efficiencies and/or new markets for the industry. Adoption of a formalized review process would help alleviate concerns that environmental commitments are being made without an investigation of their economic implications.

It has also been suggested that the introduction of cost-benefit analysis could, in conjunction with proper scientific evaluation of given environmental problems and proposed solutions, assist in assigning priority to proposed environmental initiatives. It should be

understood that the principal determinant of priorities must remain the relative severity of and danger posed by individual environmental concerns. Imperial Oil's submission put the case this way:

> Our concern is founded on the ever-increasing number of planned initiatives, each of which in isolation may have merits in terms of making some contribution to environmental quality, but when taken together could well be beyond our collective means from a financial and human resources perspective. Failure to set priorities increases the risk of sub-optimum public policy, whereby work on high priority problems is delayed or precluded as a result of directing our attention and limited resources to lower priority areas.(9)

It appears entirely rational that the economic costs and benefits of proposed environmental measures, and of rejecting or mitigating the proposed initiatives, always be measured along with the anticipated environmental benefits and costs of both options. To assist the federal government in implementing its Green Plan and to help industry devise cost-effective responses to environmental initiatives, we therefore recommend:

Recommendation no. 9

That the federal government, when introducing major environmental initiatives, be required to perform a detailed assessment of the following:

(a) **the environmental benefits and costs of both the proposed initiative, and of not proceeding with the initiative;**

(b) **the economic costs and benefits (including compliance costs, employment effects and the impact on regional and international competitiveness) of such action to the industries directly affected, as well as to other industries which may be affected.**

Recommendation no. 10

That cost-benefit analyses of the sort proposed in Recommendation no. 9 be made public for review and comment, prior to implementation of the environmental initiative in question, and that ample time be accorded for public input.

THE NEED TO QUANTIFY SOCIAL COSTS

Energy and mineral investment decisions have historically been based almost exclusively on economic criteria. Until recently, the environment has often been treated as if it were a free resource. In such cases, the environmental costs of energy and mineral activity have been borne by society at large, not charged directly to the user or to the producer of energy or mined products. The lack of internalization of these social costs, has led to over-investment in energy forms that are environmentally more harmful.

Prices play a central role in market economies, in that scarce resources are allocated through market mechanisms based on these prices. If the environment is regarded as a scarce resource, one can argue that there can be an optimal allocation of resources only if environmental costs are reflected in the price of the products under consideration.

Proponents of less-polluting energy sources often argue that for the environmental playing field to become level the prices of conventional energy products must reflect their full environmental cost. The Committee is sympathetic to their concerns, and at the same time recognizes that the economic impact of including externalities in Canadian investment planning decisions and rate making could be substantial. Canada's ability to incorporate these environmental costs into energy prices unilaterally is held by some to be rather limited. We are therefore not suggesting immediate internalization. However, since the market by itself is imperfect in doing so, governments may increasingly need to consider policy instruments that take environmental costs into account.

The host of policy instruments that can help to internalize the social costs of industrial activity are touched on below. Before these policy measures can be implemented, however, we must know the pollutant emissions from the various sources of energy and their financial cost.

There is an acute absence of information in Canada on the magnitude of the environmental costs of our production, distribution and use of energy and minerals. While there has been considerable discussion, no Canadian jurisdiction has tried to determine the true social and environmental costs of competing energy forms. We believe that the federal government should prepare a full study on the issue. The Committee therefore recommends:

Recommendation no. 11

That the federal government, in conjunction with its study of the full fuel cycle environmental impacts of energy and mineral activity (Recommendation no. 7), attempt to assign a dollar value, where possible, to the environmental damage, and render public a comparative assessment of the study results for all energy sources studied.

THE NEED FOR IMPROVED POLICY INSTRUMENTS

A number of policy instruments exist which introduce environmental considerations into decision-making. They include tougher environmental standards, environmental charges and taxes, subsidies to more environmentally benign energy choices and tradeable emissions permits among others.

Traditionally, whenever governments have acted to protect the environment, they have for the most part turned to "command and control" forms of regulation and legislation, such as placing a cap or ceiling on pollutants and assigning a prescribed route for industry to take in order to achieve the objective. Over the years, as regulation after regulation has been introduced, a complex regulatory system has developed, one which many argue is now imposing unreasonable and unintended constraints on industry's ability to operate and to respond to the environmental challenge.

Many industry witnesses argued that this approach to environmental protection must be rethought, now that industry is facing a growing list of environmental concerns. Some witnesses called for both a rationalizing of the current regulatory structure and movement towards a greater role for market forces in the achievement of environmental objectives.

One thing needs to be made clear. The objective of regulatory reform, as the Committee sees it, is not to reduce the cost of regulation to industry simply to accommodate industry's desires. While simplification and standardization of regulation are desirable to reduce delays and improve competitiveness, relaxation of regulations without equivalent or greater positive effect from the use of other policy instruments is not. The overriding aim should be to regulate more wisely, so that the regulations can be more effective.

In enhancing government efforts to provide for environmental protection, we should also consider new approaches to dealing with environmental problems. We have therefore included a brief discussion of market-based incentives which encourage industry to exceed regulatory targets.

A. Regulatory Reform

The Committee heard much criticism of the existing regulatory system. Witness after witness spoke of its complexity, inconsistency and associated uncertainty, its inefficient, and occasionally contradictory administration, its lack of flexibility and the lack of coordinated application by the various levels of government. In short, the message was that existing environmental regulation lacks coherence and is overly complex; this results in an increasingly unmanageable cost for industry from delays and duplication. The Canadian Electrical Association (CEA) summed it up as follows:

> The ever growing web of environmental regulation is proving expensive and time consuming to meet, as well as uncoordinated and even contradictory. Industry, recognizing the need for sound environmental performance, considers it essential that environmental goals be achieved through an efficient, coordinated regulatory approach, minimizing duplication and cost while rendering a conclusive decision.(10)

It is not difficult to understand how the current situation came about. Each regulation has been, to a large extent, imposed on an incremental basis as new environmental problems have arisen, with little thought of the impact of each regulation on the entire regulatory system. While each regulatory initiative may have had ample merit in its own right, and may have been well grounded on scientific knowledge, the cumulative burden of the system on the resource sector has become significant.

Industry complained of the high compliance costs of dealing with this tangled "web" of regulation, arguing that the money spent could have been allocated more productively to other purposes. One witness, from the Canadian Association of Oilwell Drilling Contractors, noted that the Association's members were often confused about which federal department to turn to with respect to a particular environmental concern.(11) The lack of a sole regulator system greatly increased administrative costs for the Association's members.

We do not wish to overly centralize the regulatory decision-making system at the federal level, because we recognize that line departments have amassed considerable expertise over the years. Yet we agree with industry groups that the system requires greater cohesion. We endorse the CEA suggestion that Environment Canada take the lead role in defining

environmental problems and stating the conditions to be satisfied, while leaving the line departments to devise and implement appropriate solutions. An integral part of this process would be consultation with industry as to preferred responses, consultation which could be improved if a new decision-making process was established. We therefore recommend:

Recommendation no. 12

That the federal government establish an interdepartmental coordinating committee on environmental regulation, with Environment Canada taking the lead role, which would have as its main objective the ongoing implementation of regulatory coherence as new regulations are developed.

Moreover, industry groups registered strong disapproval of the delays experienced in receiving approval for large-scale investment projects. Such delays can impose substantial costs on energy and mining industries, as they ponder investments which are critical to their long-term future. All this takes place in industries which already experience significantly long lead times and need sizeable infusions of funds prior to production (on average, $45 million per mine). The Mining Association of Canada suggested that lengthy regulatory delays could seriously decrease the returns from investment. For instance, a two-year delay prior to development of an "average" base metal deposit could lower the internal rate of return of the project by a full percentage point (from 14%); a four-year delay could result in a two percentage point drop.(12)

Representatives of the mining sector, as well as others, argued that, because Canada is a price taker in world markets, it cannot pass on the costs associated with what they claimed was often inefficient regulation to its consumers without harming its competitiveness. Instead, firms must absorb these costs and make adjustments in other areas.

The Mining Association of Canada and others called for a comprehensive analysis of the burden placed on industry by the existing regulatory system. While the Green Plan did contain a federal government commitment to assess the environmental impacts of present legislation, regulation, policies and programs, it did not mention a review of economic impacts. We believe that there is an urgent need for a full review of the economic impacts of regulation and of the contribution of the existing system towards mitigation of the negative impact of industry activity. To encourage the financial health and competitiveness of industries, the government needs to minimize the costs of regulation to the degree possible, consistent with maximizing environmental protection. We therefore recommend:

Recommendation no. 13

That the federal government publish a guide to regulations affecting the energy and mineral sectors, providing a comprehensive list of the regulatory instruments in place, and urge provincial governments to do likewise.

Recommendation no. 14

That a comprehensive study be carried out of the cumulative effects of the entire federal environmental regulatory system, including an examination of both its environmental benefits and economic costs and benefits.

In this regard, the unique features of the Canadian federal system present difficulties to policy-makers and industry through the important issues of jurisdictional authority and regulatory overlap, both of which were described by industry as significant obstacles.

Perhaps nowhere is jurisdictional overlap more evident than in the mining sector. Duplication of regulation in uranium mining is a pressing concern for the nuclear sector, particularly now as attempts are being made to develop new high-grade uranium facilities. The Mining Association of Canada referred to several other examples of duplication: the Department of Fisheries and Oceans' Environmental Effects Monitoring Guidelines and British Columbia protocols, Ontario's Municipal Industrial Strategy for Abatement Program, and the Federal Environmental Assessment Review Agency and provincial legislation.(13)

For many witnesses the solution lay in greater coordination between federal and provincial governments. Conventional energy producers and mining interests expressed a strong desire to place the environmental assessment responsibility for new investments with the level of government directly responsible for the project in question—most often the provincial authorities. To harmonize environmental assessment criteria, industry urged the adoption of equivalency agreements permitting provincial regulatory processes to dominate if they satisfied federal criteria.

Jurisdictional disputes over environmental assessment of new capital projects have been increasing in recent years, as the federal government has broadened its regulatory authority. Regulatory duplication, by increasing industry's cost for satisfying regulatory requirements, lowers its financial capacity to effect environmental protection. The Committee urges the federal government to work with the provinces to continue, as they have begun with the Federal Environmental Assessment and Review Act, to resolve these jurisdictional obstacles quickly and to coordinate improvement to the regulatory system across the country, by harmonizing conflicting regulations, and removing those found to be unnecessary.

The Green Plan paints a future of tougher regulation. It is therefore imperative that steps taken to ensure the establishment of increasingly strict standards of environmental performance not cause undue costs of compliance and delay. Quoting again from the CEA,

> It is clear that a coherent, coordinated and practical regulatory regime must be developed. The rules must be clear and the path for approvals timely and certain. We need an efficient, flexible and transparent approach. The cost to Canadians in terms of economic competitiveness, standard of living and quality of life of inefficient, inappropriate regulation is simply too high to tolerate.(14)

There was widespread agreement that regulation needs to move away from the traditional "command and control" style and become more flexible to encourage innovative approaches to developing new technologies. This is hampered if it falls to government to specify which technologies or processes should be used to achieve regulatory objectives. Instead, the government could be responsible for setting performance standards, leaving the meeting of the standards thus set to the private sector. We therefore recommend:

Recommendation no. 15

That the federal government adopt a more flexible approach to the regulation of environmental issues, with a full investigation of all regulatory options being done before regulations are set.

Recommendation no. 16

That the regulatory system be improved to foster innovation, and adjusted where regulations are found to be redundant or unnecessary.

B. The Use of Economic Instruments

Evidence was presented to the Committee on the need to explore whether the increased use of alternative policy instruments could solve environmental problems more efficiently and cost-effectively than traditional "command and control" regulation. Tradeable emissions permits, environmental charges and subsidies are viewed by both industry and Environment Canada as being potentially useful in achieving environmental objectives. For the most part, markets take environmental costs into account only when compelled to do so by regulation or other government device; economic instruments can serve to assign a price to environmental deterioration and thus stimulate mitigating behaviour.

As was noted above, regulation has been used almost exclusively over the years to address environmental concerns, yet it is generally acknowledged that economic instruments can deliver environmental responses more cost-effectively in certain applications. This could entail significant benefit, given the current economic difficulties in the energy and mining industries.

Whereas regulations assign certain targets and other tasks and procedures directly to polluting agents, economic instruments can serve as a useful complement to regulation by encouraging the market itself to determine the precise methods of achieving established targets.

Economic instruments, created in concert with the setting of performance standards, provide each business with the flexibility to develop the most innovative and cost-effective strategy by which that firm can meet the standards. When a price is placed on environmental degradation, producers can reduce their input costs by minimizing environmental impacts. The experience in the United States with tradeable emissions permits suggests sizeable cost savings.(15) The success of such programs there has led various environmental groups in that country to lobby for an increase in their use.

Under a typical permit program, a firm with a relatively high ability to respond to environmental requirements can profit from its advantage by selling its unused permits to companies less able to meet environmental targets. Such a system lowers the compliance costs of industry as a whole, as pollution abatement is concentrated among those polluters with the lowest costs of control. Over time, the aggregate emissions target is ratcheted downwards by the government, as it monitors the situation.

In the above model, the market is provided with an important incentive to be constantly vigilant to technical changes in the environmental area that can provide economic returns. The use of economic instruments provides the market with an enhanced ability to cope with, and even exceed regulatory requirements, at reduced cost and with less economic dislocation.

The Canadian experience with economic instruments has been negligible. Their use in this country poses some interesting and diverse practical challenges, such as regional, local and sectoral considerations, which require careful attention and analysis.

The Green Plan expressed considerable interest in this potentially important policy option, and committed the government to the preparation of a discussion paper on the use of economic instruments and certain practical aspects of their design and implementation. This discussion paper has now been released, and the government has embarked on a consultation process on their practical application.

While many of the industry groups that appeared before the Committee, including the representatives from Environment Canada, expressed a keen interest in using market forces for environmental protection, there was little detailed discussion of individual policy instruments and the practical elements of their implementation. For that matter, there was little discussion at the Committee's hearing on the relative merits of the various options, economic instruments not having been a principal focus of this study.

This Committee, however, in an earlier study of the federal government's Energy Options report, put itself on record as opposing the use of a carbon tax, arguing that it would be quite punitive and inequitable in that it would hit hardest those regions most heavily reliant on hydrocarbon production and use, and, like all sales and excise taxes, those poorer individuals less able to meet the added costs. No evidence has appeared to make us change our view.

On the other hand, there would seem to be fewer equity-based objections to implementing tradeable emissions permits for such applications as SO_2 and NO_x/VOC. As we have not undertaken a close examination of the issue, however, it is difficult for us to express an informed and detailed opinion on the correct policy direction for government. We recommend:

Recommendation no. 17

That the government undertake to consult widely on the use of economic instruments with all major stakeholders, including environmental groups, by means of an improved decision-making process (recommended above), and implement a realistic action plan derived from the process.

GLOBAL CLIMATE CHANGE

Global climate change is considered, by many analysts, to be the single most important environmental issue facing the world today, and the one likely to have the greatest effect on the Canadian energy sector. It differs from other environmental concerns in several important

respects. First, unlike the acid rain problem or ground-level ozone, global climate change, as the name suggests, is a truly global problem whose solution, as many countries, including Canada, have come to realize, requires a substantial degree of international cooperation and coordination.

A second critical feature of global climate change is its possible magnitude and the consequent economic effects of policy responses. Ill-considered reactions by policy-makers could, as witnesses reminded us, have disastrous impacts on the domestic, and for that matter, international economy. Yet research into the economic and social effects of environmental policy in this area is in its infancy.

The same can be said about the scientific underpinnings of global climate change. An extremely important feature of this issue is the relative lack of scientific certainty regarding its scope. Whereas the science behind such phenomena as acid rain and ground-level ozone has been developed over many years, and is comparatively easy to assess, only recently has the mainstream scientific community devoted considerable attention to global climate change. While there remains uncertainty about the magnitude and nature of any future climatic changes, the Committee believe that, in matters of the global environment, prudence lies not in waiting for irrefutable proof of process and consequent damage, but rather in taking action on the basis of sound initial indications.

Global climate change has, however, now become the focus of considerable and intense discussion as a prime energy policy issue. It has also become the centre of considerable negotiation at the international level, as countries throughout the world attempt to come up with policy responses. For example, Canada is an active participant in the Intergovernmental Panel on Climate Change (IPCC).

When the House of Commons Standing Committee on Energy, Mines and Resources launched its hearings into sustainable development in the Canadian energy and mineral sectors, one of its fundamental objectives was to provide the federal government and its negotiating team for the United Nations Conference on Environment and Development (UNCED) with a detailed report on how these sectors could realistically respond to demands to control greenhouse gas emissions. While detailed information was not obtained, we were able, through our Interim Report,[16] to make a positive contribution to the UNCED process by submitting industry's concerns and by recommending a negotiating position for the government. The following six pages represent a clarification of the Interim Report.

In general, industry told the Committee that it supports domestic action to help mitigate the threat of global climate change, and the continuation of active participation in international negotiations on this issue. We agree with this point of view. Canada should take every step to become a world leader in the implementation of effective domestic measures to reduce greenhouse gas emissions. It is often to our competitive advantage to do so. Having said this, we see considerable advantages from the provision of aid to other, less fortunate nations to pursue similar greenhouse gas emission reductions.

Industry voiced a number of concerns regarding (a) the extent to which the global climate change issue remains clouded in uncertainty; (b) the means by which domestic action has been formulated; and (c) the need for a Canadian position at international negotiations which will

take adequate cognizance of our high degree of energy intensity and our international competitive position. Evidence from the Ministers of Environment and Energy, Mines and Resources has led us to conclude that the concerns of industry are being heard and are continuing to have an impact at the federal level.

We were particularly encouraged by the general objectives for the Canadian UNCED position as outlined to the Committee by the Minister of Environment. As the Minister noted, the Canadian approach aimed to ensure that the UNCED framework convention would include:

- targets and schedules for limiting emissions;
- a comprehensive approach, allowing for action on all sources and sinks of emissions;
- the concept of "net" emissions;
- an effective response from both environmental and economic perspectives;
- cost-effective responses to climate change, both at the national and international levels;
- adequate and additional financial resources for developing countries; and
- an institutional framework capable of managing the climate change issue over the long term.(17)

It is hard to find fault with these broadly stated objectives. However, we share industry's expressed concern that much of the groundwork necessary for an effective realization of these objectives remains to be done. We wanted to ensure that Canada's international commitments would allow us the flexibility to develop responses that would be effective from both an environmental and an economic point of view. This flexibility must, as the Minister of Environment noted, allow us to take the most effective action, whether domestically or internationally.

A. Industry Concerns

It was argued before the Committee that the federal government ought to be more active in advancing scientific knowledge about global warming, thereby helping to reduce the present uncertainty about the cause and scope of climatic change. We are pleased to note that while the Committee was hearing testimony the federal government announced an $85 million initiative aimed at improving our scientific understanding of global climate change. This should help to alleviate industry's concerns in this regard.

The point was made that the domestic implementation strategy for greenhouse gas emissions reduction, needs to be comprehensive, encompassing all forms of greenhouse gases (not just CO_2) and all types of carbon sinks. The implementation plan should also be flexible, in that it should be able to adapt to changing scientific information. Finally, the response should be national in scope, not targeted towards a particular region, and should also rely on industry and provincial government cooperation.

These are all relatively straightforward and non-controversial arguments which are fully compatible with the basic principles of the federal government's National Action Strategy (NAS) on global warming. Yet industry argued, in some cases vehemently, that the NAS suffers from two serious omissions: notably, the failure to underscore the critical need to integrate economic considerations into environmental policy, and related to this, the fact that the greenhouse gas stabilization commitment was made without consultation and thus without a realistic appraisal of its economic implications.

Several witnesses referred to the "arbitrary" nature of the emissions reduction target and to the fact that the 1990 baseline emissions figures have not yet been determined. The Committee urges the government to make public the methodology it will use in making this determination. In addition, the question of CO_2 ownership and responsibility has not yet been resolved.

Fossil fuel interests, the most important component of our energy sector and the groups most affected, criticized the government for not basing its CO_2 commitment on a comprehensive cost-benefit assessment of what such an undertaking (and associated implementation measures) might imply for the sectors in question. There was a general desire to delay implementation of the NAS until the economic effects were known with greater precision. The consensus seemed to be that the effects of meeting the proposed national GHG target were potentially serious for a nation so dependent on fossil fuel energy, and for a region such as Western Canada with an abundant fossil fuel resource and an economic future so vitally tied to hydrocarbon production. Conventional energy producers would prefer to adopt a policy of "no regrets," with emphasis on cost-effective conservation and efficiency improvement measures. Industry, in fact, has a long history of adapting its production processes so as to improve energy efficiency. The Committee fully acknowledges the successes of industry in this field, and urges energy and mineral firms to continue and even accelerate their efforts.

Finally, several witnesses stressed the need for implementation of an effective decision-making process. A multi-stakeholder group could attempt to reach consensus on realistic strategies for implementing the NAS. It could also provide important input into the Canadian negotiating position, as international discussions continue beyond UNCED '92.

B. Towards a New Direction for Canada's Greenhouse Gas Emissions Strategy

The Committee agrees with industry and environmental groups that the implementation of an effective greenhouse gas emissions strategy is of the utmost urgency. We also are of the opinion, however, that a critical precondition of establishing a successful implementation plan is a sound knowledge of the environmental, economic and social impacts of certain policy measures. It is certainly true that "while it is necessary to integrate environmental factors into business and economic decisions, it is equally necessary to examine the economic implications of environmental policy, if only to satisfy ourselves that such policies are practical and practicable."(18)

While we are aware that federal officials are examining a more formal process of multistakeholder consultation, we believe that now is the time to act. In order for Canadians to respond more quickly and more effectively to reducing greenhouse gas emissions, we recommend:

Recommendation no. 18

That the federal government set Canada on a new course of action for its greenhouse gas emissions strategy by convening a series of consultations with all the major energy and environmental stakeholders to discuss the global climate change issue and the environmental and economic implications of various implementation measures, with the federal government then deciding on a detailed action plan.

Recommendation no. 19

That as soon as possible the federal government provide stakeholders with a discussion paper on the potential costs and benefits of alternative strategies geared to achieving reductions in greenhouse gas emissions.

The Committee believes that global problems require global solutions and global accounting. For this reason, we urged the Canadian negotiators at UNCED to support the adoption of a global greenhouse gas emission goal. Given the outcome of the UNCED negotiations, Canada should at least maintain its domestic GHG emission goal, bearing in mind that such a goal may or may not be attained. Both the Ministers of Energy, Mines and Resources and the Environment reiterated before the Committee the government's commitment to a domestic goal of stabilizing greenhouse gas emissions not covered by the Montreal Protocol at 1990 levels by the year 2000. Canada is still working out the details of how this goal can be achieved.

There was widespread agreement among the industry representatives heard by the Committee that Canada should not take any substantial unilateral action to reduce greenhouse gas emissions which would damage our economic performance and our international competitive position. We cannot disagree with this notion, which, as far as it goes, can be applied to all the environmental issues and to both the energy and mineral sectors. Given the fact that Canada is both a natural resource-intensive country and an exporting nation, it is imperative that Canada take into account its comparative advantage in natural resources, which have historically contributed enormously to our economic growth. As the Minister of Environment, and other witnesses told the Committee, without a developing economy it is difficult to support sound environmental management.

Given the fact that a range of actions to improve environmental performance can also augment our competitive position, it is equally imperative that Canadian industry maximize its efforts in these areas. Cost-effective improvements in energy efficiency are a good example. Such improvements can, and have, over time, helped to reduce business costs while enhancing our competitive position with regard to energy intensive products. Furthermore, pollution prevention and control technologies create new export opportunities for Canadian business, as do new alternative energy technologies. We therefore urge Canadian industry to redouble its efforts to take full advantage of these opportunities, and to aim at becoming a world leader in these areas.

Compared to that of other industrialized countries, our energy and mineral production and processing account for a disproportionate share of our economic output. Because of this the global climate change issue poses a particularly complex challenge for Canada. The need

to reduce greenhouse gas emissions must always be balanced against the need to sustain our energy and mineral sectors. As a result of our particular situation, our commitment to stabilization can be considered equivalent to a nominally greater commitment by economies without our strong natural resource base.

We would therefore propose that Canada, while striving to achieve stabilization through economically viable domestic action, make a firm pledge to assist in the global effort to reduce greenhouse gas emissions. Taking action in certain other countries can often be more effective from both an environmental and a cost point of view, than additional action taken domestically. A number of witnesses suggested that countries should adopt a non-uniform approach to the reduction of global greenhouse gas emissions. It was argued that steps taken abroad could prove to be more cost-and environmentally-effective than domestic action for a highly energy-intensive, relatively high efficiency producer such as Canada. For example, the transfer of Canadian technology and expertise to developing countries where growth in greenhouse gas emissions is anticipated to be high could, at the margin, achieve greater environmental benefit than corresponding action at home. The coal industry has been a particularly keen advocate of this approach, arguing that the cost of achieving a given reduction in greenhouse gas emissions from coal-burning operations in certain developing countries would be significantly lower than attaining a similar reduction domestically.

We strongly support this approach. The federal government's stabilization goal is, as we have already stated, just that, a goal: it may be attained or it may not be. If Canada finds that this goal is not economically attainable through domestic action, it should be permitted to satisfy its international obligations through a concerted overseas effort. We therefore recommend:

Recommendation no. 20

That the federal government seek a global commitment to a reduction, to be achieved by coordinated global efforts, of total global, anthropogenic greenhouse gas emissions by 20% from 1990 levels by the year 2005.

Recommendation no. 21

That, to help meet any commitments reached as part of any future global climate change convention, the federal government support proposals to facilitate Canada taking global action and receiving international credit for this action, such as contributing, financially and through technology transfer, to emissions reduction efforts in other countries.

PROMOTING ENERGY ALTERNATIVES AND EFFICIENCY/CONSERVATION

Proponents of alternative energy sources and enhanced energy efficiency consistently told the Committee that changes were required to federal energy policy-making if the potential of these options were to be realized. While it has been illustrated that a strategy of aggressive

conservation and efficiency measures coupled with much greater use of renewable energy sources such as solar and wind would bring substantial improvements in reducing Canada's emissions of greenhouse gas emissions and other harmful pollutants, several market barriers block this development.

Foremost among these is the inability of the market to calculate the environmental costs of energy activity which, therefore, are not borne by the producers and consumers of energy products that cause them but rather by the biosphere. The difficulty in incorporating these costs fully in the price of energy products, however, gives an advantage to conventional, well-established energy producers, and thus is seen as inhibiting the introduction of conservation strategies and renewable sources into the market.

The difficulty is that, while some preliminary work has been done on social cost assessment, no definitive work has been carried out for the Canadian situation. Until this is done, it will be difficult for governments to design cost-effective and appropriate environmental policies for conventional energy producers and to identify the possible contribution of renewable energy sources. We therefore reiterate our previous recommendation that the federal government undertake a study of social costing.

Placing dollar values on environmental impacts is considered by many to be an essential step in the establishment of environmental policy. Certainly, various policy tools can reduce environmental impacts and narrow the price gap between the established patterns of energy production and consumption on the one hand, and the currently available conservation and alternative energy possibilities on the other. These tools could include providing financial incentives for clean technologies; imposing environmental charges on polluting activities based on the environmental damage done; establishing measures such as tradeable emissions permits, which would force some firms to pay for clean technologies; and reducing or eliminating the subsidization of conventional energy producers.

This last option requires some elaboration. Historically, federal and provincial governments have intervened in their energy sectors through subsidies to firms and a sizeable tax burden on certain energy products. It became clear during our hearings, that the extent of the imbalance in Canada has not been fully assessed. A comprehensive analysis of how equitably federal fiscal policies treat the various energy options would be useful. We therefore recommend:

Recommendation no. 22

That the federal government undertake a comprehensive assessment of the impact which its fiscal regime (including subsidies and taxes) exerts on the various energy sources, both renewable and non-renewable.

Other steps the federal government could take to enhance the competitive position of alternative energy sources and the implementation of energy efficiency measures include: carrying out further assessments of alternative energy resources; providing the public with greater information on both options; creating financial vehicles to channel funds towards renewable energy technologies; increasing the government's own research, development and

demonstration (R,D&D) in this area; and generally supporting energy efficiency and renewable energy. The Committee heard that a useful means of realizing gains in energy efficiency and the use of renewable energy sources is the setting of national targets where this is appropriate and feasible. We therefore recommend:

Recommendation no. 23

That using an improved decision-making process (see Recommendation no. 2), the federal government develop and set targets and timetables for reducing Canadian energy consumption where appropriate and feasible and for increasing the share of domestic energy production accounted for by renewable energy technologies.

We favour movement towards greater diversity of our energy mix. To this end, we view renewable energy technologies as an important complement to conventional energy sources. These technologies can serve to diversify Canada's energy supply and electric generation base, making it more robust and increasing overall reliability, and at the same time provide environmental benefits. In order to assist renewable energy options in achieving greater market penetration, the Committee recommends:

Recommendation no. 24

That the federal government initiate renewable energy resource assessments in those sectors or jurisdictions where these have not been adequately compiled.

Recommendation no. 25

That the federal government increase support for basic research in alternative energy development and establish mechanisms to funnel financial resources to the developers of renewable energy technologies.

We also see considerable potential for cost-effective energy efficiency measures that do not impose net negative impacts on the economy. While we acknowledge the progress that industry has made, much more needs to be done, if we are to achieve our environmental objectives. Governments must do more to knock down the barriers to greater use of efficiency-enhancing technologies. They have various policy vehicles at their disposal: the imposition of higher efficiency standards than the market would otherwise provide; greater use of information programs; and various forms of subsidization to encourage energy efficiency investments, to name a few.

REWARDING ENERGY EFFICIENCY

If Canada is to take its environmental challenges seriously, it is generally recognized that a determined effort to improve the efficiency of energy use will need to be undertaken. This is the case since reducing the consumption of energy will reduce the level of all energy-related emissions. The promotion of energy efficiency needs also to be viewed as an important element in the drive towards enhanced industrial competitiveness, and ultimately our long-term prosperity.

To make significant improvements in energy efficiency without jeopardizing the competitive advantage that energy provides, governments throughout the country will have to come forward with innovative solutions. What is required is not layers upon layers of additional taxes and regulation placed upon already beleaguered industries, for such action would have serious implications for our international competitiveness. Instead, new systems need to be created which, while providing relatively cheap energy inputs for industry, will reward efficient energy use.

Put another way, how do we as a society decouple energy consumption from economic growth without adversely affecting the competitive strengths of natural resource-based industries vitally dependent upon inexpensive energy? What follows are some examples of policy instruments which can provide policy-makers with a sense of the direction on which they should embark. They are in no way meant to represent the definitive policy course for governments to take.

Generally, these suggestions are in keeping with the new direction in environmental protection which favours an expanded use of economic, or market-based instruments. The underlying rationale for the shift in policy approach is the growing recognition that the harnessing of market forces through the use of financial incentives and/or penalties can, in a number of situations, be more effective in achieving environmental benefit than traditional regulatory tools.

As Table 16.1 indicates, Canadian energy demand is heavily focused on two key end-use sectors: industrial and transportation. Together, these account for almost two-thirds of domestic demand. If we are to meet our environmental objectives, it behooves us to find new policy instruments which would target these sectors and encourage changes in energy consumption therein without undermining our economic performance.

Table 16.1

Secondary Energy Demand in Canada by Sector, 1991 (petajoules)

Sector		**(%)**
Residential	1,362	(20.6)
Commercial	1,053	(15.9)
Industrial	2,405	(36.4)
Transportation	1,785	(27.0)
Total	**6,605**	

Source : Energy, Mines and Resources Canada and Statistics Canada, *Energy Statistics Handbook*

A. The Industrial Sector

The industrial sector accounts for approximately 37% of secondary energy demand. A large proportion of this energy use is concentrated in a small number of industries. All told, pulp and paper, mining, iron and steel and chemicals together account for about 60% of total industrial demand.

Given existing levels of concentration in energy use, and the fact that the number of industrial entities in this country is of a manageable proportion from a program administration point of view, it would be a relatively straightforward task for the federal government to devise an incentive scheme which would provide bonuses to firms using energy at less than threshold levels. While we leave the practical aspects of program design to others, one program which could be envisaged would be based on the calculation of historical (eg. five-year moving averages) industry-wide energy consumption and an assessment of how a particular firm's performance in this area would measure up when compared with industry averages. For those firms below threshold levels, for example, the government could provide an incentive in the form of a Federal Energy Efficiency Tax Credit or Rebate.

The establishment of such an inducement would undoubtedly provide Canadian industry with a powerful incentive to seek methods to use energy more efficiently. The federal government already provides tax incentives to stimulate investments in scientific research and development. The program envisaged here would instead be targeted towards real environmental achievements.

Another way to structure the incentive program would be to reward firms with tax credits on the basis of the energy savings achieved relative to their own past consumption. Thus, if a firm reduces its energy use per unit of output by 20%, it could then be eligible for an additional 20% rebate. Conversely, if the company in question registers a deterioration in performance, a corresponding penalty could be assigned. Some allowance for the impact of energy price changes would undoubtedly need to be included to factor out significant movements in price.

B. The Transportation Sector

The transportation sector is also a major consumer of energy, accounting for slightly under 30% of total energy demand and almost 70% of petroleum requirements. Road transportation is the dominant mode.

While continued use could be made of enhanced standards for efficiency improvements in new automobiles and light trucks, there are a number of economic instruments available which also could improve vehicle fuel efficiency. One program which has been adopted in the United States is a "cash for gas-guzzler" scheme designed to ferret out old, inefficient vehicles. These, in the main, are the vehicles which account for a sizeable proportion of existing transportation pollution.

Under this scheme, designed to help meet local air pollution targets under the Clean Air Act, the federal government permits energy companies and state governments to collect marketable pollution credits by purchasing old vehicles for scrap. Trading in credits is expected

to begin in 1994. By providing a market-based incentive to take energy-inefficient vehicles out of circulation, the local region reaps an environmental benefit in the form of improved air quality, at a cost which is often less than that incurred through traditional forms of regulation. The motorist also gains in that he/she can use the cash payment as a disbursement on a newer, less environmentally harmful vehicle.

Another policy tool for the transportation sector is the use of a sipper/guzzler scheme for automobiles. As the federal government's recent discussion paper on economic instruments points out, a system combining subsidies and environmental charges can have a favourable impact on movement towards more efficient automobile materials and technologies and on consumer decisions regarding vehicle purchases.[19] Under such a scheme, differential charges can be applied on vehicles based on their fuel efficiency ratings, either at the point of purchase or preferably during the annual licensing stage. If a vehicle achieves superior km/litre performance, the owner is rewarded with a rebate on the licensing charge; on the other hand, if fuel efficiency is below threshold levels, then a punitive fee is applied. In this way, consumers are induced to move away from more polluting and towards less polluting vehicles.

The concept of a gas-guzzler tax is not a new one. As far back as 1978, federal U.S. legislators imposed such a tax on cars not meeting fuel efficiency standards established by the Environmental Protection Agency. Domestically, the Province of Ontario already imposes a Tax for Fuel Conservation, but this tax applies only to new vehicles, which are considerably more fuel efficient than older ones. For vehicles exhibiting low energy use, purchasers receive a government rebate of $100. More recently, a report of the Ontario Fair Tax Commission recommended that this "feebate" program be expanded, and that the revenues collected in the form of fees be employed in the purchase of old vehicles for scrap (see above comments on the U.S. scheme).

Yet another option, albeit considerably more restrictive, would involve the provinces issuing a fixed supply of gasoline coupons. Daily commuters and other coupon users would then be required to purchase additional coupons for their own use. A market incentive would therefore be introduced to lessen fuel use.

C. The Residential Sector

Similar incentive schemes could be devised for home energy use, which accounts for slightly over 20% of total secondary energy demand. Designing a national program becomes somewhat more complicated, however, in that different regions of the country display different home energy use patterns and thus utility rates, as well as different climatic conditions. All of these variables must be factored in when establishing a household program intended to bonus efficient users of energy.

As in the case of industrial and transportation energy use, the basic concept that we have in mind is a simple one. One possibility is a voluntary scheme whereby individuals would agree to pay a fee to have their heating/cooling units certified for their degree of energy efficiency by government-trained and regulated inspectors. If the unit(s) in question meets or exceeds certain predetermined energy efficiency standards (Class A to Class E, for example), the individual who pays the energy bill would be entitled to a rebate based on the efficiency

standard achieved. This program would rely more on the efforts made to improve energy efficiency, and less on the results in terms of actual dollars spent on energy use. Given the number of inspections which would periodically need to be made as investments in energy efficiency are undertaken, greater administrative costs would also be involved.

Perhaps a better alternative to reduce residential demand would be to encourage the provinces to enable their respective utilities to fold investments in demand-side management (DSM) into their rate base, so that these would generate a return—increasingly, a higher one than that achieved on supply-side investments. Such a regulatory practice, common in many U.S. states, would stimulate new efforts in achieving more efficient use of energy, as well as potentially providing consumers with cheaper energy bills.

D. Financing the Bonus Systems

There are several ways to finance expenditure options of the kind mentioned above. We would prefer that the federal government not raise additional tax dollars from the energy industries and thereby jeopardize industrial competitiveness. Revenues from fees collected through charges such as the gas guzzler tax should most certainly be made available for transfers to efficient energy users. Additional money could be found from reductions in subsidies to upstream activity, in particular major capital projects, or alternatively through reductions in other areas of government spending.

E. Towards an Alteration of Domestic Energy Consumption Patterns

To reiterate, if Canadians are to achieve energy efficiency gains in this environment of low real energy prices, they must be encouraged by governments to do so. Rewarding efficient energy use would enable us to satisfy our environmental objectives while maintaining the competitive advantage which abundant and cheap energy bestows. We therefore recommend:

Recommendation no. 26

That the federal government assign a higher priority to energy conservation and efficiency and to reducing demand in its energy planning and policy decision-making.

Recommendation no. 27

That the federal government, in conjunction with its provincial counterparts and in consultation with other major energy stakeholders, devise innovative solutions to achieving energy efficiency gains. These would be tailored to providing firms and consumers with monetary inducements to use energy in a more efficient manner.

MINING ISSUES

In addition to the important issue of acidic mine drainage, which is discussed in Chapter 5, two other issues deserve special attention: land reclamation and related tax assistance, and the Green Plan's commitment to developing an enhanced national parks system. The latter undertaking represents a direct Canadian response to the Brundtland Report's recommendation that 12% of a country's land mass be set aside as protected natural area.

In most provinces, land reclamation is a fact of life for mining companies. Firms must satisfy provincial requirements for existing mines and must also include reclamation plans in the development of new mining operations. These requirements pose a significant financial challenge for mine operators since much reclamation can take place only after an operation is shut down; the problem lies in the fact that expenditures must be made, though production revenues have ceased.

The Committee was told that a number of provinces have plans to require mining firms to set aside funds for this purpose in advance of a mine's closure.[20] This led to discussions with industry on the possibility of deducting these funds from taxable income. In 1990, a government-industry task force concluded that a case could be made for deductibility, and discussions on its form and implementation are currently taking place. In order to provide the mining industry with greater financial certainty, we urge the government to conclude these discussions expeditiously.

During our hearings on the mining sector there was also some discussion of land use conflict, particularly in view of the federal government's objective to increase the Canadian network of national and provincial parks. In all, 12% of domestic land is to be designated as protected space by the year 2000. The House of Commons registered support for the completion of this network in a June 1991 resolution.

Inevitably, the protection of so much new land from industrial (predominantly mining, oil and gas, forestry and tourism) activities implies significant land use conflict. To help minimize this, the federal government is using Mineral and Energy Resource Assessments (MERAs) in the establishment of national park boundaries. A sophisticated mapping system (the National Land Use Data Base, or NATLUS) has identified those lands not accessible to the mining industry and industry has responded by setting up the Mineral Industry Land Use Committee.

If the 12% commitment is to become reality, we believe it is imperative to assign priority to removing the uncertainty over this issue. We share the view of the Canadian Nature Federation (CNF), which argues for a swift identification of proposed protected areas by the federal and provincial governments which will respectively account for one-quarter and three-quarters of the 12% target. To quote the CNF,

> The early identification of candidate protected areas will provide the mining industry with a greater degree of certainty with respect to access to mineral ore bodies, and possibly reduce land use conflicts.[21]

We agree with the thrust of the CNF's proposal, and recommend:

Recommendation no. 28

That the federal government, in conjunction with provincial governments and after full consultation with all interested parties in order to help avoid potential land use conflicts, complete an early identification of proposed park boundaries.

RESEARCH AND DEVELOPMENT

The federal government's research and development role has consistently attracted wide support from the energy and mineral sectors, although proponents of alternative energy sources and energy efficiency have vehemently criticized present spending allocations. Generally, however, the programs put in place to encourage industrial innovation have been well received.

We are also of the view that R, D&D is an important role for government, but we have concerns about the share of the science and technology budget devoted to environmental issues, and to the development of alternative energy technology and energy efficiency opportunities. We therefore recommend:

Recommendation no. 29

That the federal government re-allocate its energy R&D budget, devoting a significantly larger share to environment-related research, and to research in the renewable energy sector and energy efficiency and conservation.

Throughout the chapters of this Report dealing with the individual energy and mining sectors, we have highlighted a number of Canadian leading-edge technologies which we believe could hold considerable commercial potential. These would include such technologies as the fuel cells, photoelectrolysis systems and the application of ecological engineering to the clean-up of mine sites.

As pointed out in the chapter on hydrogen (Chapter 14), we are of the view that, apart from exceptional cases, it should not be government's role to choose the firms whose technologies are "winners". Instead, we feel that governments, in cooperation with industry, should identify general areas of promising technological development and target R&D expenditures accordingly. We therefore recommend:

Recommendation no. 30

That the federal government target its R&D expenditures on Canadian leading-edge technologies, where possible without selecting individual firms as "winners".

EXPORT DEVELOPMENT

The Committee sees the export of technology and expertise to natural resource-producing countries with severe environmental problems, as an important aspect of Canada's overall attempts at environmental control. Developing countries in particular are seen as future beneficiaries of the transfer of Canadian technology, given their large population and population growth rates and paucity of skills and financial resources. Many of these countries are less able to undertake innovative, but costly, environmental protection strategies on their own.

There was little substantial criticism of governments' efforts to encourage such transfer. Industry generally supported the current division of tasks, in which industry is responsible for the development of the technology and governments assist with export promotion and

financing.[22] But this does not imply that more cannot be done. We believe, in fact, that greater priority should be assigned to this endeavour, principally but not exclusively within the programs offered by the Export Development Corporation and the Canadian International Development Agency. The Committee thus recommends:

Recommendation no. 31

That the federal government place greater emphasis within its export development programs on transactions for transferring to developing countries technologies designed to mitigate environmental harm.

ENDNOTES

(1) Coal Association of Canada, "Canadian Environmental Challenges: A Perspective by the Coal Association of Canada," Brief presented to the House of Commons Standing Committee on EMR, October 1991, p. 5.

(2) Canadian Electrical Association, "Environmental Challenges Facing the Electric Utility Industry," Brief presented to the House of Commons Committee on EMR, September 1991, p. 12-14.

(3) Coal Association of Canada (October 1991), p. 5.

(4) Canadian Petroleum Association, "The Canadian Petroleum Association's Response to Current and Future Environmental Challenges," Submission to the House of Commons Standing Committee on Energy, Mines and Resources, October 1991, p. 9.

(5) Canadian Petroleum Products Institute, "Environmental Challenges: A Perspective from the Canadian Petroleum Products Institute," Brief presented to the House of Commons Standing Committee on EMR, December 1991, p. 25.

(6) Canadian Petroleum Association (October 1991), p. 22.

(7) Coal Association of Canada (October 1991), p. 4.

(8) Independent Petroleum Association of Canada, Brief presented to the House of Commons Standing Committee on Energy, Mines and Resources, 26 September 1991, p. 14.

(9) Imperial Oil, Submission to the House of Commons Standing Committee on Energy, Mines and Resources, 15 October 1991, p. 4.

(10) Canadian Electrical Association (September 1991), p. i.

(11) Canadian Association of Oilwell Drilling Contractors, Brief presented to the House of Commons Standing Committee on Energy, Mines and Resources, November 1991.

(12) Mining Association of Canada, Fact Sheets on Mining and the Environment, submitted to the House of Commons Standing Committee on Energy, Mines and Resources, November 1991.

(13) Mining Association of Canada, "Environmental Challenges to the Mining Industry," Brief presented to the House of Commons Standing Committee on Energy, Mines and Resources, September 1991, p. 13.

(14) Canadian Electrical Association (September 1991). p. 29.

(15) See T.H. Tietenberg, *Emissions Trading: An Exercise in Reforming Pollution Policy*, Resources *for the Future*, Washington D.C., 1985, p. 41-58.

(16) Canada, House of Commons Standing Committee on Energy, Mines and Resources, *Sustainable Energy and Response to the Environmental Challenge: An Interim Report on the Issue of Global Climate Change*, 24 February 1992, Ottawa, 9 p.

(17) The Honourable Jean Charest, Minister of the Environment, Presentation to the House of Commons Standing Committee on Energy, Mines and Resources, 13 February 1992, p. 11.

(18) Canadian Petroleum Association, Opening Statement to the House of Commons Standing Committee on Energy, Mines and Resources, 20 November 1991, p. 1.

(19) Government of Canada, *Economic Instruments for Environmental Protection, A Discussion Paper,* 1992, p. 67.

(20) Ron R. Sully, "Minerals and the Environment," Speaking Notes for presentation to the House of Commons Standing Committee on Energy, Mines and Resources, 2 October 1991, p. 15.

(21) Canadian Nature Federation, Correspondence to the Committee, 13 January 1992, p. 3.

(22) Canadian Petroleum Association (October 1991), p. 33.

Appendix A

List of Consultants

Name	Title	Company / Organization
David W. Heeney	Associate	VHB Research & Consulting Inc.
Terry Jamieson	Manager	Science Applications International Corporation (SAIC Canada)
Peter Linder	Director, Natural Gas Research	Canadian Energy Research Institute
Alan Logan	President	International Technology Ventures Ltd.
Morgan MacRae	Director, Coal & Electricity	Canadian Energy Research Institute
Jeff Passmore	President	Passmore Associates International
Anthony Reinsch	Vice-President	Canadian Energy Research Institute
Earle A. Ripley	Professor Department of Crop Science & Plant Ecology	University of Saskatchewan
Vincent Roquet	Project Officer	Option Aménagement Inc.
Michael Ross	Partner	Peat, Marwick, Stevenson & Kellogg

Appendix B

Organizations which prepared sector reports for the Committee

Sectors	Organizations
Biomass Energy	Biomass Energy Institute Beth Candlish Executive Director
Coal	Coal Association of Canada Giacomo Capobianco President
Electricity	Canadian Electrical Association Wallace S. Read President
Energy/Efficiency	National Energy Conservation Association Laverne Dagleish Chief Executive Officer
Hydrogen	Hydrogen Industry Council Richard D. Champagne President and Chief Executive Officer
Mining	Mining Association of Canada C. George Miller President
Natural Gas	Canadian Gas Association Ian C. McNabb President
Nuclear Energy	Canadian Nuclear Association The Honourable John M. Reid, P.C. President
Oil	Independant Petroleum Association of Canada Gerry Protti Executive Director Canadian Petroleum Association Ian Smyth President

Sectors	Organizations
Solar Energy	Solar Energy Society of Canada Inc. Ruth McKlusky Executive Director
Wind Energy	Canadian Wind Energy Association Réal Reid President

Appendix C

List of witnesses

Associations and Individuals	Date	Issue
Alberta Office of Renewable Energy Technology Mary Ellen Jones, Information Centre Manager and Secretary to the Board	December 10, 1991	10
Alternative and Conservation Energies Incorporated Jorg Ostrowski, President Helen Ostrowski, Director	December 10, 1991	10
Atomic Energy of Canada Limited Colin Allan, Vice-President, Environmental Sciences and Waste Management	October 10, 1991	3
Ballard Power Systems Keith Prater, Vice-President, Technology	October 30, 1991	5
Biomass Energy Institute Inc. Frederick E. Stock, President Edward A. Speers, Past President	October 30, 1991	5
Boojum Research Ltd. Margarete Kalin, President and Research Director	November 6, 1991	6
Canadian Association of Oilwell Drilling Contractors (CAODC) Doug Rourke, President Don Herring, Managing Director	November 26, 1991	8
Canadian Chemical Producers Association David Goffin, Secretary-Treasurer David J. Shearing, Project Manager, Business Development	October 23, 1991	4
Canadian Coalition for Nuclear Responsibility Gordon Edwards, President	October 9, 1991 October 10, 1991	3 3

Associations and Individuals	Date	Issue
Canadian Electrical Association Wallace S. Read, President Ken Adams, Division Manager, Conawapa Complex Licensing Division, Manitoba Hydro Carole Burnham, Director, Environment, Ontario Hydro and Vice-Chair, CEA Environmental Policy Committee Derek Henriques, Manager of Energy Marketing, British Columbia Hydro Fred Meth, Director, Environmental Affairs, New Brunswick Power	November 27, 1991	8
Canadian Energy Research Institute		
Peter Linder, Expert on Natural Gas	October 22, 1991	4
Anthony E. Reinsch, Vice-President, Expert on Petroleum	November 19, 1991	7
Morgan MacRae, Director, Coal and Electricity	December 3, 1991	9
Canadian Gas Association Ian C. McNabb, President Michael H. McGregor, Chair, Environment Managing Committee Paul Shervill, Member, Environment Managing Committee John S. Klenavic, Vice-President, Government Relations	October 23, 1991	4
Canadian Gas Processors Suppliers Association Howard C. Smith, President	October 23, 1991	4
Canadian Home Builders' Association Robert Sloat, Director, Technical Research	December 10, 1991	10
Canadian Institute for Environmental Law and Policy Jack O. Gibbons, Senior Economic Advisor	October 23, 1991	4
Canadian Nature Federation Kevin McNamee, Protected Areas Coordinator	November 6, 1991	6
Canadian Nuclear Association Hon. John Reid, President Ian Wilson, Vice-President, Technology Tim Meadley, Vice-President, Mining (President, Uranium Saskatchewan)	October 9–10, 1991	3

Associations and Individuals	Date	Issue
Canadian Petroleum Association Ian R. Smyth, President P. Douglas Bruchet, Vice-President, Health, Safety and Environment R.J. Ottenbreit, Vice-Chairman, Environment Standing Committee Gary A. Webster, Coordinator, Health, Safety and Environment	November 20, 1991	7
Canadian Petroleum Products Institute Claude Brouillard, President Guy Archambault, Director (President, Ultramar Canada) Robert Clapp, Chairman, Environment, Health and Safety Committee	December 10, 1991	10
Canadian Renewable Fuels Association Jim Johnson, President Ken Hough, Research Advisor	October 30, 1991	5
Canadian Wind Energy Association Réal Reid, President Jason Edworthy, Past President Malcolm Lodge, Member	December 10, 1991	10
Coal Association of Canada Dr. Giacomo Capobianco, President Joe Kostler, Manager, Environmental Affairs, Alberta Power Jim Popowich, Vice-President, Development and Alberta Operations, Fording Coal Ltd. Bevin Laing, Manager, Power Resources Development, Alberta Power Dermot Lane, Manager, Environmental Affairs, Fording Coal Ltd.	December 3, 1991 December 4, 1991	9 9
Edmonton Power Stan Gent, Project Manager, District Energy	December 10, 1991	10
Electrolyser Corporation Ltd. Alexander K. Stuart, President and General Manager	October 30, 1991	5

Associations and Individuals	Date	Issue
Energy, Mines and Resources Canada Bruce Howe, Deputy Minister David Oulton, Assistant Deputy Minister, Energy Sector R. Sully, Assistant Deputy Minister, Mineral Policy Sector Marc Denis Everell, Assistant Deputy Minister, Mineral and Energy Technology Sector E.A. Babcock, Assistant Deputy Minister, Geological Survey of Canada	October 2, 1991	2
Rajindar S. Rangi, Technology Officer (Wind), Alternative Energy Division	December 10, 1991	10
Energy Probe Norman Rubin, Director, Nuclear Research	October 10, 1991	3
Environment Canada Len Good, Deputy Minister Kirk Dawson, Director General, Canadian Climate Centre, Atmospheric Environment Service Laura Tupper, Acting Director, Industrial Programs Branch, Conservation and Protection Ian Rutherford, Director General, National Parks, Canadian Parks Service Bob Slater, Assistant Deputy Minister, Corporate Policy Group	October 3, 1991	2
Fisheries and Oceans Canada Dr. John Rudd, Research Scientist, Freshwater Institute	November 27, 1991	8
Friends of the Earth David Brooks, Former President	November 20, 1991	7
Gestion Gamac Aurélien Gill, President	November 27, 1991	8
GT Communications Trevor T.M. Jones, President and Chief Executive Officer	November 20, 1991	7

Associations and Individuals	Date	Issue
Hepler Research and Consulting Ltd. Loren G. Hepler, Professor Emeritus, Chemistry and Chemical Engineering, University of Alberta	November 20, 1991	7
Hydrogen Industry Council Richard Champagne, President Robert D. Murray, Chairman, Board of Directors William Yurko, Member, Board of Directors, Western Region	October 30, 1991	5
Imperial Oil Ltd. R.E. Landry, Vice-President J.P. McFarland, Vice-President, Environment and Safety P.G. Wright, Technology Planning Manager, Esso Petroleum Canada J.A. Hughes, Manager, External and Business Analysis	November 20, 1991	7
International Technology Ventures Ltd. Alan Logan, Consultant on Hydrogen	October 29, 1991	5
Iogen Corporation Dr. Bryan Foody, President	October 30, 1991	5
Machinery and Equipment Manufacturers Association of Canada Dale Letts, Chairman, Mining Machinery and Equipment Section Frank Hlovski, Vice-President	November 6, 1991	6
Mining Association of British Columbia Tom Waterland, President Ken Sumanik, Director, Environment and Land Use	November 6, 1991	6
Mining Association of Canada George C. Miller, President Keith Hendrick, Chairman Hennie Veldhuizen, Vice-President, Environmental Services, Noranda Minerals Robert Keyes, Vice-President, Economic Affairs	November 6, 1991	6

Associations and Individuals	Date	Issue
National Energy Board Roland Priddle, Chairman Jim Klotz, Director, Financial Services	June 6, 1991	1
National Energy Conservation Association Jack Parsons, Chairman Laverne Dagleish, Chief Executive Officer Tony Woods, Director Peter Etherington, Vice-Chairman Pat Hunter, Member	December 11, 1991	10
Newfoundland Light and Power Bernard J. Ryan, Director, Environmental Policy	November 28, 1991	8
Ontario Conservation Council John McRuer, Member of the Energy Committee	December 4, 1991	9
Option Aménagement Vincent Roquet, Expert on Hydro-Electricity	November 26, 1991	8
Passmore Associates International Jeff Passmore, Consultant on Wind and Solar Energy David Argue, Associate	December 9, 1991	10
Peat, Marwick, Stevenson and Kellogg Michael Ross, Consultant on Energy Conservation and Efficiency	December 9, 1991	10
Pembina Institute Rob McIntosh, Executive Director	December 11, 1991	10
Propane Gas Association of Canada Bill Kurtze, Managing Director C.S. Dempsey, Technical Director	October 23, 1991	4
Prospectors and Developers Association of Canada Hugh Squair, Member, Board of Directors and Environment Committee	November 6, 1991	6
Rawson Academy of Aquatic Science Dr. Peter G. Sly, Director of Science Program	November 27, 1991	8
Ripley, Prof. E.A. Expert on Mining and Smelting University of Saskatchewan	November 5, 1991	6

Associations and Individuals	Date	Issue
Science Applications Inc. Corp. T.J. Jamieson, Consultant on Nuclear Energy	October 8, 1991	3
Solar Energy Society of Canada Christian Ouellet, President Dr. Raye Thomas, Past President Douglas P. Lorriman, Director	December 10, 1991	10
TransAlta Utilities Corp. Ken McCready, President and Chief Executive Officer Jim Leslie, Senior Vice–President, Corporate Services	December 4, 1991	9
United Mine Workers of America William E. Stuart, President District 18	December 4, 1991	9
VHB Research and Consulting Inc. David W. Heeney, Consultant on Biomass	October 29, 1991	5

Appendix D

List of submissions

Alberta Office of Renewable Energy Technology

Alberta Oil Sands Technology and Research Authority (AOSTRA)

Alternative & Conservation Energies Incorporated

Association québécoise pour la maîtrise de l'énergie

Atlantic Wind Test Site

Atomic Energy Control Board (AECB)

Atomic Energy of Canada Limited (AECL)

B.C. Hydro

Ballard Power Systems

Boojum Research

BOURQUE, Mr. Denis
Professor
University of Quebec at Chicoutimi

BRODERICK, Mr. John

Calgary Chamber of Commerce

California Energy Commission

Canadian Association of Oilwell Drilling Contractors (CAODC)

Canadian Chemical Producers' Association

Canadian Coalition for Nuclear Responsibility

Canadian Energy Research Institute (CERI)

Canadian Gas Processors Suppliers Association (CGPSA)

Canadian Geothermal Energy Association

Canadian Home Builders' Association

Canadian Institute for Environmental Law and Policy

Canadian Institute of Mining, Metallurgy and Petroleum (CIM)

Canadian Member Committee World Energy Council (CANWEC)

Canadian Nature Federation

Canadian Oxygenated Fuels Association (COFA)

Canadian Petroleum Products Institute (CPPI)

Canadian Renewable Fuels Association Inc.

Canadian Society of Petroleum Geologists

Canadians for Responsible Northern Development

CanMET (Canada Centre for Mineral and Energy Technology)

Conseil des Atikamekw et des Montagnais Inc.

Coppostona Tree Farm

Edmonton Power

Electrolyser Corporation Ltd.

Energy, Mines and Resources Canada

Energy Probe

Environment Canada

Environmental Impact Review Board

Fisheries and Oceans Canada

Forum québécois du complexe Grande-Baleine

Fraser Institute (The)

Friends of the Earth

Friends of the Fraser Valley

Fundamental Research Institute (Dr. A.K. Ray)

GT Communications

GARSONNIN, Mr. Daniel

Geological Association of Canada

George C. Marshall Institute

Gestion Gamac

GIBSON, Robert B. (Ph.D.)
Associate Professor
Faculty of Environmental Studies
University of Waterloo

HEPLER, Dr. Loren
Dept. of Chemistry
University of Alberta

HODGINS, Barbara L.

Hydro-Québec

Imperial Oil Ltd.

Indian and Northern Affairs Canada

Institute for Integrated Energy Systems
University of Victoria

Jacques Whitford Environment Ltd.

Ligue des femmes du Québec

Mineral Industry Land Use Committee (MILUC)

Mining Association of British Columbia

Mining Machinery and Equipment Manufacturers Association of Canada (MEMAC)

Newfoundland Power

Nisymco Marketing

Nova Scotia Dept. of Natural Resources

Nuclear Awareness Project

Office of Technology Assessment (U.S. Congress)

Oleophilic Sieve Development of Canada Ltd.

Ontario Ministry of Energy

Ontario Natural Gas Association

Ortech International

Petroleum Monitoring Agency

Petroleum Resources Communications Foundation

Planetary Association for Clean Energy, Inc.

Propane Gas Association of Canada

Prospectors and Developers Association of Canada

Rawson Academy of Aquatic Sciences

Saskatchewan Mining Association Inc.

Science Council of Canada

Siddhartha Communications

Small Explorers and Producers Association of Canada (SEPAC)

Suncor Inc.

Syncrude Canada Ltd.

TEED, Eric L.

TransAlta Utilities Corporation

TWEEDDALE, Mr. R.E.

United Mine Workers of America (District 18)

Uranium and Nuclear Energy Consultants

REQUEST FOR GOVERNMENT RESPONSE

Pursuant to Standing Order 109, the Committee requests that the Government table a comprehensive response to its Report.

A copy of the relevant Minutes of Proceedings and Evidence of the Standing Committee on Energy, Mines and Resources (*Issues Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16, which includes this Report)* is tabled.

Respectfully submitted,

AL JOHNSON, M.P.
Chairman

SUSTAINABLE ENERGY AND MINERAL DEVELOPMENT :

A Realistic Response to the Environmental Challenges

Liberal Dissenting Opinion

David Kilgour, M.P.

January, 1993

CHAPTER FOUR

The definition and operational implications of sustainable development have been firmly established for over ten years, including the watershed 1987 report of the UN Commission on Environment and Development, Our Common Future. It is therefore correct to assume that the Canadian government has identified the magnitude of current environmental problems and the likely economic impacts, both positive and negative, and that a reasoned and ordered set of environmental priorities have been identified.

Each year Environment Canada produces a comprehensive report entitled, The State of Canada's Environment Report. In the 1992 Report, for example, Chapter 12, "Energy: A Balance of Power", begins by stating that Canada is one of the most energy-intensive economies in the world, with one of the highest—if not the highest—per capita energy consumption ratios in the world. The Report outlines environmental impacts of energy use, as well as problems of acid rain and climate change. In addition, Chapter 22 of the 1992 Report outlines greenhouse gas sources, possible climatic shifts, Canadian contribution to the greenhouse effect, impacts on agriculture, forests, sea levels, freshwater resources, permafrost, wildlife and habitats, protected areas, etc. These are just two of numerous detailed, credible reports detailing the environmental impacts of energy use. On the international front, the OECD, the United Nations, the International chamber of Commerce and many other organizations each year publish detailed reports on environmental problems, as well as cost-effective, demand and supply side energy efficiency solutions.

Clearly, enough information exists for government and industry to respond. Equally true, the precise definitions of sustainable development have been established for years. In the 1987 Brundtland Report, there is a clear recommendation that "a sustainable energy pathway is crucial to sustainable development." Clearly issues of sustainability for non-renewable energy sources like oil are different from renewable sources. Income from an exhaustible resource is, by definition, not sustainable forever. Accordingly, the question becomes a question of what is done with the net proceeds, or economic rents, from extraction. If all proceeds are spent on short-term consumption, then income from oil resources are not sustainable. But, if rents are invested in assets—in increasing efficiency, improving net inputs, reducing wasteful outputs—then a limited form of energy sustainability can be achieved. Technologies exist now whereby demand-side energy use for durable goods like light fixtures, home insulation, transport fuel efficiency, can be improved drastically—by up to 70 per cent or more.

Canada has already committed itself to stabilize carbon dioxide emissions by the year 2000. Is that not a priority? The Green Plan sets out priorities to address climate change, through such measures as minimum energy efficiency standards, the labelling of products to indicate energy efficiency levels, stricter building codes, greater public awareness, etc. It is not more consultations that we need, it is a commitment by the public and private sectors to stop talking about environmental goals, and start acting.

As troubling as this Committee's suggestion that there is a lack of credible, relevant information about implementing environmental policies is the persistence, in Chapter Four's sub-heading "The Need for a Realistic Response to Environmental Demands", of the false dichotomy between a healthy economy and a healthy environment. Canada is missing an

economic opportunity to strengthen its overall efficiency, reduce its per capita and per output energy intensity, by following through on its commitment to reduce greenhouse gas emissions. Improved energy efficiency enhances productivity and competitiveness. One of the reasons Japan and Germany have enjoyed such economic strength in the last decade is because they are considerably more energy-efficient than Canada.

CHAPTER SIXTEEN

The report reflects the strong consensus in Canada for greater consultation in determining environmental targets. The recommendations for greater transparency and participation in standard settings, and the need for a full fuel cycle analysis of all energy sources is welcome.

Under "The Need to Quantify Social costs", the observation "since the market by itself is imperfect... government may increasingly need to consider policy instruments that take the environmental costs into account." In light of vast improvements in environmental accounting and natural resource accounting, the Government should do far more than "consider" such options: it should rather commit itself, as Germany, Norway and other countries have already done, to preparing a parallel set of national income accounts, indicating the costs of natural resource degradation and environmental damage.

Under Recommendation 15, a "more flexible approach" to the regulation of environmental issues should not be translated into a more lenient enforcement of existing or future regulations. Under Recommendation 17, a timetable should be established for consultations on economic instruments, given the fact that there are now strong signals that the new Clinton Administration will turn increasingly towards economic instruments like tradeable permits in order to achieve environmental goals. Instead of waiting to see what will happen, this Committee should recognize that—although not a policy panacea—economic instruments of the mineral, energy and other sectors must become a cornerstone of Canada's economic and environmental strategies.

While it is an obvious point that "Canada is both a natural resource-intensive and exporting nation, it is imperative that Canada take into account its comparative advantage in natural resources", the Committee fails to outline the economic and environmental advantages of increased investment in value-added capacity and export potential. More emphasis should be contained in the Report on job and market share opportunities in cleaner technologies and value-added economic activities.

Recommendation 21 should refer to the role greenhouse gas offset credits would play in a global climatic regime. The Government, as well as the Global Environmental Facility, should assist industry in identifying opportunities for carbon reduction credits, particularly in Eastern and central Europe.

Under Chapter 16's sub-heading "Promoting Energy Alternatives and Efficiency/Conservation", the notion that financial incentives should be forthcoming only for "environmental damage done" is confusing, since it undermines the previous call for greater scientific data to identify existing and potential problems.

In Recommendation 26, the Government has already assigned, under the Green Plan, high priority to energy conservation and efficiency. Canadians do not need more identification of priorities: they need specific targets, including a 50% improvement in energy efficiency for electrical appliances by the year 2000, published data on energy efficiency, and an expansion of the Green Seal Program of the Government to include energy efficiency audits for consumer goods, etc.

SUSTAINABLE ENERGY AND MINERAL DEVELOPMENT:

A Realistic Response to the Environmental Challenges

New Democratic Dissenting Opinion

Ross Harvey, M.P.

January, 1993

The report contains some valuable contributions to the public debate concerning environmentally sustainable energy policy. The most important of these include the following:

1. Energy efficiency and conservation must be a major focus.

The report accurately states that "Virtually every industry witness who appeared before the Committee listed improved energy efficiency and/or conservation as one of the principal components of the strategy for meeting environmental challenges." (p. 123) Pursuit of this approach is entirely realistic technically since "many of the most important and helpful energy efficiency technologies are well-developed, well-established and fairly simple to incorporate into current commercial and industrial plant." (p. 129-130) Moreover, "pursuing effective energy conservation and efficiency measures would make Canadian business more competitive." (p. 33)

The report makes several important proposals designed to spur energy conservation and efficiency. These include proposals to increase federal government research, development, and demonstration (p. 46), set specific energy consumption reduction targets (Recommendation #23), assign a "higher priority" to energy conservation and efficiency (Recommendation #26), take "all possible action to again reverse the trend and start back on the road to improved (new motor vehicle) fuel efficiency" (p. 128), and examine innovative taxation and incentive ideas (p. 56). Specific proposals for legislation would have been helpful, but the urging of action in principal is welcome.

2. Alternative sources of energy should also receive much greater federal government support.

Portions of the report clearly reflect Members' keen interest in alternative energy sources. For example: "The Committee is of the opinion that, principally for environmental reasons but for other economic and commercial reasons as well, solar energy will be the energy source of choice in the future. The implications for technology development and marketing are little short of revolutionary" (p. 112). Similarly, the report states that "(w)ind energy is recognized as one of the most environmentally benign technologies capable of generating utility grade electricity" (p. 103). "A more balanced playing field, in which all costs, including social and environmental costs, are taken into account would allow wind energy to play a significantly greater role in Canada" (p. 105). However, the report correctly states that "(t)o be successful, the wind energy industry would require a champion in government" (p. 105). The same can safely be said for Canada's nascent solar energy industries.

The report recognizes the contribution that biomass energy can play in reducing carbon dioxide emissions. Biomass fuels are often "not a net contributor to the greenhouse effect" because they "can be seen as 'backing out' or replacing fossil fuels which . . . otherwise would have been used . . . (thus reducing) the amount of new carbon taken up from the lithosphere and deposited in the atmosphere" (p. 93).

The Committee enthusiastically endorses two new potentially renewable energy technologies, stating: "The Committee believes that Canada could derive significant benefit in the long term if . . . the fuel cell being developed by Ballard Industries, and the photovoltaic/electrolysis system of Electrolyser Corp. . . . were commercialized in a timely manner." (p. 115) As well,

such technologies "have the potential to have such a profound impact . . . that Canada should take all necessary steps to ensure that their development can continue as a product owned and controlled in this country" (p. 119).

The Committee laments that "government support for renewable energy R&D has been cut to the bone over the last decade" (p. 101).

3. Government subsidies now favour traditional energy supply sources rather than conservation and alternatives

For example, the Committee notes that direct government subsidies are "skewed toward energy supply (i.e., the oil and nuclear sectors) and away from conservation" and that "(i)ndirect subsidies such as funding for highway construction" make "rapid transit systems less economical to operate" (p. 129).

The Committee recommends a study of energy subsidies (Recommendation #22) and notes, as only one example, that "(a) more balanced playing field, in which all costs, including social and environmental costs, are taken into account would allow wind energy to play a significantly greater role in Canada" (p. 105). Again, the same can safely be said for solar and other alternatives.

4. The report highlights important environmental challenges facing individual energy sectors that are often either ignored or down-played elsewhere.

For example, and to the Committee's great credit, the chapter on nuclear energy begins with the following frank assessment: "The main environmental challenges facing the nuclear power industry arise from its dependence on the mining, concentration, use and disposal as waste of extraordinarily persistent and poisonous material" (p. 47).

Thus, the report recognizes the expense associated with the nuclear industry, stating in this regard that "no commercial nuclear power plant anywhere in the world has to date been decommissioned successfully" (p. 55). The Committee also questions "whether or not the money that has been collected (for decommissioning reactors) is actually available for the stated purpose" (p. 55).

Finally, the report indicates that the association of tritium emissions with incidence of leukemia near nuclear power plants warrants "continued judicious concern" (p. 52).

The report also considers a number of lesser-known environmental challenges facing other energy sectors including new evidence that hydroelectric reservoirs emit the potent greenhouse gas methane (p. 86), and a concern that municipal solid waste incinerators emit dioxins and furans (pp. 92-3).

Commendably, the report repeatedly emphasises the need to avoid simplistic 'point of use' environmental assessments in favour of a "full energy cycle" analyses (see Recommendation #7).

Unfortunately, despite the important positive aspects mentioned above, the report is deeply flawed. Due to space limitations, only the most important flaws are considered here:

1. The main purpose of the Committee was not achieved.

The Committee announced the aim of its work and solicited input in a national advertisement that stated that the Committee was investigating "Canada's energy and mining sectors with the aim of identifying and proposing realistic solutions to the challenges of sustainable development and protection of the environment."

Unfortunately, in the vast majority of submissions, "detailed information on cost-effective... options and the costs to industry of responding to environmental initiatives was not forthcoming" (p. 2). As a result, the Committee was forced to shift its attention to other issues which, although they are of interest, are tangential to the original important objective.

2. The Report fails to transmit an appreciation for the profound significance of global warming and thus constitutes a serious abdication of the Committee's responsibility.

(a) The Committee was unwilling to acknowledge that the phenomenon of global warming is a fact and that it is accepted as such by the overwhelming majority of the world's scientists.

Instead, the Committee's proceedings contained numerous gratuitous attacks on the scientific basis of the phenomenon. Indeed, the phrase "global warming" was almost totally expunged from the text in favour of the far less definitive phrase "global climate change". In this instance, this amounts to distinct lack of intellectual rigour in that: (a) the majority of the Energy Committee Members refused to pursue the possibility of examining the issue in joint hearings with the Environment Committee, (b) the Energy Committee failed to study the issue itself, and (c) the Energy Committee has never even attempted to refute the conclusions and expressions of urgency contained in the report of the Environment Committee which did examine the matter.

(For a concise statement of the problem, readers are invited to read the March 1991 Environment Committee Report entitled "Out of Balance: The Risks of Irreversible Climate Change". The New Democrat Caucus supports that Committee's recommendation that ". . . a 20% reduction in human-sourced CO_2 emissions by the year 2005, compared to the 1988 level of emissions, be adopted by the federal government as its minimum interim objective in reducing Canadian CO_2 emissions".)

(b) The Committee majority used the lack of final and complete scientific certainty regarding aspects of global warming to rationalize its own lack of political will to address the problem.

By its very nature, science involves various degrees of uncertainty and the science of atmospheric change is no exception. It is true that there exists considerable uncertainty regarding the precise nature of the processes involved in global warming, the relative importance of each of its major causes, its absolute magnitude, and its likely future effects in any specific region. Unfortunately, the Committee seemed unable to distinguish these relevant but subsidiary issues from the pivotal point that there is overwhelming evidence that the phenomenon of global warming itself is a fact.

In any event, even allowing for rather large margins of uncertainty, the policy makers' task on global warming is to weigh the risk of potentially wasted investment against the risk of unabated environmental change. After conducting a rigorous examination of the available evidence, deciding what public policy should be adopted is not a scientific question; it is a value-laden political judgement. The Committee performed a disservice by obscuring this point.

(c) **The Committee waffled on even the government's modest commitment to 'cap' Canadian domestic CO_2 emissions.**

In its first Report to the House of Commons released February 24, 1992, the Committee recommended that ". . . the federal government reconfirm its stated commitment to stabilize greenhouse-gas emissions . . . at 1990 levels by the year 2000, and that it also seek a global commitment to a reduction of total global, anthropogenic greenhouse-gas emissions by 20% from 1990 levels by the year 2005, to be achieved by coordinated global efforts" (emphasis added).

Unfortunately, the revised version of that same recommendation that appears in this subsequent report is much weaker. The Committee seems to take pains to emphasize that even that overly-modest capping goal "may or may not be attained" (p. 153). And should this so-called goal not be "economically attainable through domestic action" (p. 43) (another weakening), the Committee members insist that Canada "be permitted to satisfy its international obligations through a concerted overseas effort" instead (p. 43).

The only positive effect of this rhetorical sleight-of-hand seems to be to alert the public to the means by which the federal government may attempt to extricate itself from what Canadians once believed to be a firm commitment.

3. The report reflects the majority of Committee Members' misplaced faith in the ability of the market to solve environmental problems.

The report provides a revisionist historical analysis by indicating that "government intervention . . . caused economic pain to the province of Alberta" (p. 17) while neglecting to point out that it was the withdrawal of government intervention (in the form of the deregulation of oil and natural gas pricing and marketing in 1984-5), together with the then-determinant 'world price' collapse in 1986 and the high level of foreign control of the petroleum industry in Canada, that precipitated much of the economic pain now affecting Alberta.

While it is true that the petroleum industry's current fiscal situation is dire, the solution to these difficulties lies not with further deregulation. Rather, in the interest of the planet, one is forced to conclude that a re-regulated pricing regime is absolutely essential to the equitable generation of the funds necessary for the industry's successful meeting of its environmental challenges.

Regrettably, the Committee's infatuation with market economics frequently leads it astray.

The central focus of the report contradicts the main message of the World Commission on Environment and Development (also known as the Brundtland Report). The Committee report repeatedly refers to the need to "balance" environmental imperatives with economic priorities (p. 1) rather than the urgent necessity to integrate the two. This focus is evident in spite of the report's title and its occasional rhetorical exception and despite repeated exhortations by some members of the Committee. Even worse, the definition of these economically-supportable priorities in the report is inappropriately restricted merely to the ability of existing industry in the short term to make a "realistic contribution . . . to environmental goals" (p. 1). The majority of Committee members clearly did not fathom the full significance of the report's own expansive observation that "the central tenet of the Brundtland Report is that 'Ecology and the economy are becoming ever more interwoven-locally, regionally, nationally, and globally-into a seamless net of causes and effects'" (p. 33).

The report recommends the establishment of a "multi-stakeholder" process using the example of the Clean Air Strategy for Alberta (CASA) as a model (Recommendations #2, 3). Simply as a means for consultation, this proposal has merit, though it appears to duplicate the National Round Table on the Environment. In any event, the report ominously and specifically indicates that the idea constitutes an "improved decision-making process" (pp. 136, 138). Although the report skirts the issue of exactly what decision making role the Committee would envisage for such a group, Canadians should be on guard in the future lest such a process instituted nationally become the means by which major portions of the federal government's legitimate and essential public policy role is transferred to unelected corporate elites.

In this context, it must be emphasized that the recommendations emanating from the CASA process, "made jointly by a 13-member committee made up of representatives from petroleum and coal companies, the utilities, authorities in the health field, government agencies and environmental groups" (p. 138) are notable in that they are exceptionally 'soft', include absolutely no specific targets or timetable for controlling CO_2 emissions.

The Committee's obsession with market economics leads it to lend support to several initiatives that could prove damaging to the environment.

(a) The Committee recommends economic cost-benefit analyses of environmental initiatives (Recommendations #9, 10, 14) including "attempting to assign a dollar value . . . to environmental damage" (Recommendation #11). Unfortunately, not only would this shift the onus away from polluters, since it requires 'internalizing' 'externalities', such a task is literally impossible to achieve. Moreover, even if the task were possible, it would entail attempting to balance highly variable estimates of the monetary value of all current and future resources against the present tangible costs to individuals of environmental regulation. The result would be as skewed as it would be predictable.

(b) The Committee sometimes lends tacit support for the relaxation of environmental controls by its uncritical repetition of questionable claims even though the report is sufficiently carefully crafted for these instances to be obvious.

For example, the report states without comment the flat assertion, apparently contained in an industry study, that prairie soils are "alkaline" and that "Western Canada does not have an acid deposition problem" (p. 74). Elsewhere, apparently in response to industry concerns about a nationwide ceiling on acid-forming SO_2 emissions, the Committee dutifully recommends that an SO_2 emissions ceiling be "imposed in Western Canada only after the need for it . . . is scientifically established" (Recommendation #5). The Committee was informed but failed to mention that the study in question was restricted to Alberta and was seriously flawed. Canadians should know that a 1984 Senate Committee report entitled "Soil at Risk" indicated that "(s)oil acidification is . . . a concern" in areas of northwestern Saskatchewan. Also, a 1987 Alberta Environment publication entitled "The Sensitivity of Alberta Lakes and Soils to Acidic Deposition" (p. 24) reported that over 30% of the total surface area of Alberta show a medium sensitivity to acidic deposition and that nearly a quarter of Alberta-including large areas immediately surrounding existing petroleum facilities-have soils that are highly sensitive to acid inputs.

4. The report fails to acknowledge the urgent necessity for the federal government to create employment and economic development by actively developing and commercializing new and existing conservation and alternative energy technologies.

The next century will likely see an absolutely huge market develop in local small-scale energy generation in which wind and solar source technologies will dominate. Properly fostered, Canada's industries can compete and win in this new marketplace. Left to "the market", we will subside into insignificance. Unfortunately, such is the policy of the current government, a policy implicitly endorsed in the Committee's report.

Since the Conservatives were elected, the federal government's annual expenditures on energy conservation and alternatives has declined precipitously—from $410 million in 1984-5 to less than $50 million estimated for 1991-92. At the same time-even as it preaches the "free market gospel"—the federal government allocates billions of taxpayers' dollars to uneconomic, unsustainable fossil fuel megaprojects such as Hibernia in a way that almost ensures the chief beneficiaries of the extraction of Canadian resources are American corporate giants.

Canada is in critical need of a dramatic change of direction. The federal government should embark on an intensive program to implement the myriad existing energy conservation techniques in Canada. The government should develop an integrated industrial strategy to take advantage of a terribly brief opportunity to 'leap-frog' and then co-ordinate with other countries' research, development and commercialization of environmentally sustainable energy alternatives. And the government should begin to nurture and develop not only our own domestic market but also the huge looming market in developing countries for environmentally benign energy strategies. This approach would benefit the environment while creating thousands of desperately-needed jobs.

Change is coming. Nothing can stop it. But it will come first, most effectively and ultimately most beneficially in those nations where government takes an active co-ordinating and leadership role. Those nations where this does not happen will languish as pollution backwaters, lamely buying what advanced technologies they can from the trailblazers in the sustainable energy field.

Minutes of Proceedings

TUESDAY, DECEMBER 1, 1992
(50)

[*Text*]

The Standing Committee on Energy, Mines and Resources met *in camera* at 10:10 o'clock a.m. this day, in Room 307, West Block, the Chairman, Al Johnson, presiding.

Members of the Committee present: Rex Crawford, Louise Feltham, Ross Harvey, Al Johnson, David Kilgour and John MacDougall.

Acting Member present: Barbara Sparrow for Wilton Littlechild.

In attendance: From the Research Branch of the Library of Parliament: Peter Berg and Lynne Myers, Research Officers.

In accordance with its mandate under Standing Order 108(2), the Committee resumed its study on Sustainable Energy and Mineral Development: A Realistic Response to the Environmental Challenges. (*See Minutes of Proceedings and Evidence, dated Thursday, June 13, 1992, Issue No. 2.*)

The Committee proceeded to discuss its draft report.

It was agreed,—That the report be entitled: "Sustainable Energy and Mineral Development: A Realistic Response to the Environmental Challenges."

It was agreed,—That dissenting opinions, if so desired by the New Democratic and Liberal parties, be printed as appendices to the report, and that such opinions be no longer than five (5) or so pages at the discretion of the Chairman, and that they be submitted to the Clerk of the Committee no later than Friday, December 11, 1992.

At 12:05 o'clock p.m., the Committee adjourned to the call of the Chair.

THURSDAY, DECEMBER 3, 1992
(51)

The Standing Committee on Energy, Mines and Resources met *in camera* at 10:15 o'clock a.m. this day, in Room 307, West Block, the Chairman, Al Johnson, presiding.

Members of the Committee present: Al Johnson, David Kilgour, Bob Layton, Wilton Littlechild and John MacDougall.

Acting Member present: Barbara Sparrow for Louise Feltham.

In attendance: From the Research Branch of the Library of Parliament: Peter Berg and Lynne Myers, Research Officers. *From Ross Harvey's Office:* Jim Grieshaber-Otto, Legislative Assistant.

In accordance with its mandate under Standing Order 108(2), the Committee resumed its study of Sustainable Energy and Mineral Development: A Realistic Response to the Environmental Challenges. (*See Minutes of Proceedings and Evidence, dated June 13, 1991, Issue No. 2.*)

The Committee proceeded to discuss its draft report.

It was agreed,—That the draft report, as amended, be adopted as the Committee's Second Report and that the Chairman present it to the House, or if the House has adjourned, to the Clerk of the House.

It was agreed,—That, pursuant to Standing Order 109, the Committee request the Government to table a comprehensive response to the report within 150 days.

It was agreed,—That, the Chairman be authorized to make such grammatical and editorial changes to the report as may be necessary without changing the substance of the report.

It was agreed,—That, in addition to the 550 copies printed by the House, the Committee print 2,450 additional copies of its report in separate English and French versions, at the discretion of the Chairman, and that the additional cost be imputed to the budget of the Committee.

It was agreed,—That the list of consultants who helped prepare the report, the list of witnesses who appeared before the Committee, the list of sector reports and the list of individuals and groups who made written submissions be printed as appendices to the report.

It was agreed,—That a Press Conference be held after the report is presented to the House or to the Clerk of the House; and that the location of such Press Conference be Edmonton, Calgary or Ottawa at the discretion of the Chairman, with an undertaking to provide adequate notice of same to Committee Members of the Opposition parties.

It was agreed,—That the Committee express its gratitude to the Members who participated in the Report Working Group, the Researchers, the Clerks and their support staff, for all their efforts in preparing the report.

At 11:35 o'clock a.m., the Committee adjourned to the call of the Chair.

Nancy Hall
Clerk of the Committee