INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries

CANADA 2000 REVIEW

OECD

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INTERNATIONAL ENERGY AGENCY
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The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

It carries out a comprehensive programme of energy co-operation among twenty-four* of the OECD's twenty-nine Member countries. The basic aims of the IEA are:

- To maintain and improve systems for coping with oil supply disruptions;
- To promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations;
- To operate a permanent information system on the international oil market;
- To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- To assist in the integration of environmental and energy policies.

** IEA Member countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States. The European Commission also takes part in the work of the IEA.*

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- To achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- To contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- To contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996) and the Republic of Korea (12th December 1996). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

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SUMMARY AND RECOMMENDATIONS

SUMMARY

Canada's endowment of all forms of relatively low-cost energy resources has made possible the development of an energy economy based on energy-intensive industries, and has given rise to Canada's role as an energy supplier to the US, and as a coal and nuclear technology supplier to Asia. The distribution of resources between the provinces and the separation of jurisdiction for the energy sector has led to different patterns of development in the provincial energy sectors and to marked differences in energy policy between the provinces.

Canada's plentiful hydro and uranium resources, coupled with the development of the CANDU technology (heavy water reactor system), have enabled the development of an electricity generation industry based largely on renewable and carbon-free fuels.

General Energy Policy

Because of the division of powers over energy between the federal and provincial governments, the federal government provides a framework for the sector as a whole, but does not seek to determine policy in all areas. The focus of federal policy has been on sustainable development issues and energy efficiency. Regulatory reform in the electricity and gas industries (other than international and interprovincial trade) has been largely a function of the provincial governments. Policy is co-ordinated through formal high-level committees and informal contact between the federal and provincial governments. The federal government has primary responsibility for the nuclear industry. The provincial governments own the Crown mineral rights within their jurisdictions and constitutional responsibility for management and development of the resources. The focus of their energy policy is on resource management, economic development and on securing a fair share of the economic rent as royalties. The governments of the territories, where the federal government has responsibility for energy mineral development, are focused on the economic development of the resources.

Responsibility for regulation is shared between the federal and provincial governments. Federal regulatory powers are strong with respect to international and interprovincial trade, but market outcomes are generally endorsed. Electricity development has tended to be based on large, provincial Crown corporations, although this is changing.

Physical energy security is not an issue in Canada because of its huge and diverse energy resource base. Although no problems have arisen to date, strong growth in gas production and exports will continue and there is potential for developing gas resources in remote locations. Markets require good information to operate

effectively and governments in Canada play an important role in analysing market trends. Government agencies should ensure that market players are receiving adequate information on emerging gas transmission capacity requirements to ensure the timely and efficient expansion of gas infrastructure by private parties.

Energy-Environment Policy

Canada faces potentially high economic costs involved in meeting mandatory greenhouse gas emission targets, depending on the time frame for compliance and the instruments used. Canada has generally opted for voluntary measures supported by information programmes, market incentives and energy efficiency standards. Additional measures are being designed to meet the diverse needs of the provincial energy sectors. The federal government has given a commitment that no region should be asked to bear an unreasonable burden. In the build-up to the implementation window for the Kyoto Protocol, it will be important for the federal, provincial and territorial governments, and stakeholders, to demonstrate the effectiveness of measures preferred by Canada.

Possible new measures are being developed by government-industry working groups, called "Tables". Without the measures already in place, Canada's probable level of emissions would be about one-third higher. It is likely that stronger measures will be necessary to enable Canada to achieve its target.

The Tables process is a "bottom-up" process that should produce useful and practical proposals, based on a common understanding and analysis by all the parties. As part of the process, the Analysis and Modelling Group (one of the Tables) has constructed the modelling structure necessary to analyse the economic, environmental and social impacts of various paths to achieving the Kyoto target. It will be necessary to translate this work into a coherent package of measures which has support from all levels of government. The federal government should continue to work with the provinces towards the goal of developing an integrated implementation strategy, based on its overall analysis of the task. It should encourage the private sector to pursue least-cost abatement measures, including the international flexibility mechanisms, i.e., joint implementation, Clean Development Mechanism and emissions trading. It should tentatively quantify the potential contribution of these to achieving the Canadian target.

Energy Efficiency

The Office of Energy Efficiency has been established as the core unit responsible for delivering energy efficiency components of the Energy Efficiency and Alternative Energy Program (EAE). Its restructured programme management, based on programme outputs and outcomes and market outcomes, has increased the transparency and accountability of the programme. The use of disaggregated

sectoral energy efficiency and use indicators, and their continuous evaluation and development, is commendable.

Comprehensive regulation for appliances and buildings, supplemented by labelling, are in place in the residential and, to a lesser extent, in the commercial sector. Standards, codes and regulations cover a large share of household energy consumption and achieve – where they are of a mandatory nature – a high penetration in the market. Provided widespread adoption in the provinces can be assured, this approach should have a positive impact on energy consumption and carbon dioxide emissions despite significant growth in population and income. In the commercial sector, the effect is less marked.

In industry and transport, EAE measures rely largely on increasing awareness through targeted information and suasion mechanisms (such as voluntary commitments) for the uptake of energy efficient practices. Where behavioural changes are intended, such as in transportation, information and awareness-raising measures alone are not likely to achieve sufficient uptake and penetration of changed practices. At least in some industry sectors, rates of improvement in efficiency do not appear to be significantly higher than what could be expected without government measures. With the detailed information of past intensity changes in industry available, and the voluntary mechanisms well in place, the government should strive to encourage stronger commitments, if the overall doctrine of voluntary action is to be maintained.

The uptake of the existing, well-developed programmes could be enhanced greatly by introducing additional market-based measures. In the end-use area, the integration of existing programmes with further market-based measures is necessary to maximise their impact. The recent commercial buildings incentive programme is an example of how this might be undertaken. More stringent voluntary commitments might be negotiated in place of fiscal/regulatory requirements where competitive disadvantages for industry are expected.

New measures to improve energy efficiency are likely to emerge from the Tables process. A further strengthening of the current energy efficiency programme appears likely. The development of indicative emissions reduction objectives and targets for end-use measures, could be an initial step that would then allow a further strengthening, tailoring and prioritisation of programme measures.

The provinces have jurisdiction in many areas which federal energy efficiency programmes seek to influence. The effectiveness of federal programmes may be inhibited by their incomplete uptake in the different provinces. Closer integration of the approach taken by the federal, provincial and municipal governments would be consistent with evolving competitive energy markets.

Market Reform – Electricity and Gas

Electricity market reform has been very successful in some provinces. Some provincial governments have developed liberalised markets within provincial

borders. In addition to achieving provincial goals for jobs, investment and consumer benefits, electricity market liberalisation is being pursued to enhance access to US markets. Geography inhibits the development of a national electricity market in Canada, but there is already significant trade and potential for strong north-south regional markets, involving several provinces and adjacent US states. Interprovincial trade is not regulated. Utilities in adjacent provinces are free to enter into commercial transactions. Federal and provincial governments are in agreement on open transmission access across provincial jurisdictions.

The views of the US Federal Energy Regulatory Commission (FERC) have had a major impact on development of policy in Canada. It is likely that competitive markets will continue to develop in some provinces to bring about domestic competition and in order to gain broader access to US markets. This may require provincial market structures to conform, in part, with US Federal Energy Regulatory Commission policy despite objections (for example, from the Government of Alberta) to the extraterritorial application of FERC rules. The uneven pace of restructuring between provinces means that not all potential efficiency benefits will be realised and that investments in infrastructure could be sub-optimal. However, provinces have agreed to reciprocal access provisions in the Energy Chapter of the Internal Trade Agreement. Also, provincial regulators can be expected to facilitate investments in interconnection facilities where these would be in the consumers' interest. Similarly, the new market structures should enhance co-operation between provinces. For example, as part of electricity restructuring in Ontario, Ontario Hydro Services Company, which inherited the transmission and distribution assets of Ontario Hydro, is committed to using best efforts to expand the interconnection tie with Québec. Policies driven by provincial governments may lead to problems concerning planning for transmission and the promotion of market reform for the benefit of Canadian consumers in provinces where there is limited potential for trade, particularly with the US.

The current trend to integrate the US and some provincial markets will benefit the participating provinces and should therefore be encouraged. The policy objective should be to encourage the formation of efficient regional and international markets. Convergence of provincial markets will require the development of compatible principles under which emerging regional markets develop, if high transition costs are to be avoided and longer-term efficiency gains are to be maximised.

These considerations also have a bearing on gas. The upstream gas market is fully liberalised, and some provinces are now liberalising the downstream market. Some initial problems have been encountered in areas broadly described as consumer protection, which may affect public confidence in competition reform and the smooth transition to full opening of the domestic market.

Generally speaking, market outcomes are accepted and interventions in energy markets are exceptional. The regulator accepts freely negotiated transmission tariffs, and planning for new transmission capacity and overall assessment of security of supply are also left to the market.

Oil

Activity in Canada's conventional oil industry is gradually shifting from the mature producing areas in western Canada to the east coast offshore. It is uncertain whether conventional oil production will continue to rise as this change occurs. Growth in total oil production will depend upon increased production of bitumen and synthetic crude oil from the bituminous sands. The companies currently active in mining and upgrading of oil from the bituminous sands, led by Syncrude and Suncor, are able to produce light synthetic crude oil at a relatively high fixed cost, but low variable cost. Unlike production from a conventional reservoir, the mining of bituminous sands allows production at a fixed rate from a known resource, often using truck and shovel techniques. The present producers expect to be economic with oil prices at or above US$ 12 per barrel.

Nuclear

Nuclear power in Canada is based on the Canadian CANDU technology. Most reactors are in Ontario, where eight reactors were shut for extended periods following declining performance. No new reactors are planned to be built. Performance of nuclear power has a particular bearing on energy-environment policy as fossil fuels are presently compensating for lower nuclear output.

An extensive network of government activities, resulting from the domestic origins of the CANDU technology, backs the nuclear industry. Nuclear-related activities are directed to diverse objectives in many areas: medicine, industry, export promotion, etc. The CANDU and some other nuclear activities are at present grouped in Atomic Energy of Canada Limited (AECL). If these activities were separated, it would be easier to formulate priorities in the nuclear industry generally and in research and development. The government role in nuclear activities could then be better defined.

Renewables

Renewable energy, other than hydroelectricity, may have a limited role in Canada in the near term. There may nevertheless currently be scope for non-hydro renewables (wind, biomass and photovoltaics) in remote regions, where grid connections are uneconomic. Small-scale cogeneration and renewables may also be attractive in deregulated markets where investors seek niche markets, including peak supply and provision of ancillary services and marketing "green" power to consumers who are willing to pay a premium for energy from renewable sources. Further advancement of renewable energy may require some form of support, preferably through market-based incentives consistent with reforms that are underway in the electricity market.

Research and Development

Government research and development spending has undergone substantial restructuring in response to budget cuts and changing government priorities. As a result, transparency and accountability in federal government non-nuclear research and development spending have improved. These programmes are efficiently managed and respond flexibly to government priorities, in particular to the priority now accorded to reducing greenhouse gas emissions. The level of co-ordination with industry stakeholders is high. The large reductions in research and development budgets are a cause for concern, in view of Canada's energy-intensive economy and the challenge of reducing greenhouse gas emissions. The current level of non-nuclear research support should be reconsidered and ways of increasing funding developed.

Programmes should continue to recognise the importance of projects for the medium to long term. The contraction of budgets has focused government non-nuclear research and development spending on areas where industry money can be leveraged. Private sector initiatives can improve uptake and deployment of the results of research and development programmes and the integration of government research and development with private players is laudable. But medium- to long-term research and development may not be of interest to industry. If funding is increased in the future, an increased share of medium- to long-term research and development, as well as a reconsideration of the government role in deployment, should be considered.

Government nuclear research and development spending might usefully be reviewed in a similar way as the restructured prioritisation and spending procedures in the non-nuclear area. Nuclear research and development priorities are set in a way that is different from the process used for non-nuclear programmes. With a limited total research and development budget it is axiomatic that priorities need to be assessed with considerable care. It would be helpful if the current nuclear and non-nuclear research and development budgets were prioritised and allocated to government objectives as a whole through a single process.

Energy Resource Industries

Canada is a major energy producer and exporter. Policy reforms have minimised government influence in resource extraction industries. Micro-economic reform to lower transport costs and to raise labour productivity will remain important.

Broader industry policies, beyond the scope of this review, will play a critically important part in maintaining the viability of Canada's energy resource industries. In relation to the coal industry, it would be desirable to create a competitive rail transport system. As a Crown corporation, the federal government has financially supported coal production by the Cape Breton Development Corporation (CBDC) for more than thirty years. In 1999, the federal government

decided to privatise CBDC's operations to offer the best opportunity for long-term commercial viability. Legislation has been introduced to provide for the privatisation of CBDC's assets

RECOMMENDATIONS

The Government of Canada should:

Energy Efficiency

☐ Consider establishing clear objectives, possibly as quantified targets, for the contribution of end-use policies and programmes to reducing greenhouse gas emissions.

☐ Strengthen commitments made under voluntary agreements with industry.

☐ Develop closer relations between federal and provincial energy efficiency programmes, and assist provinces wishing to develop energy efficiency policies and programmes.

☐ Consider supplementing and integrating current sectoral programmes with economic incentives in order to maximise the uptake of efficient practices.

Energy-Environment

☐ Consistent with current policy, ensure that possible greenhouse gas emissions response measures are prioritised according to their cost-effectiveness for the nation as a whole.

☐ Build on the work of the Analysis and Modelling Group (which is being conducted as part of the Tables process) to develop a coherent package of measures to achieve Canada's greenhouse emissions target, and move quickly to reach agreement at all levels of government on a firm package of measures.

☐ Monitor progress towards achieving the share of Canada's greenhouse gas emissions target attributed to individual measures.

☐ Consider the economic implications of these measures on a regional basis in order to define regional efforts on a fair economic basis. A nation-wide emissions trading system could help equalise marginal costs and should alleviate regional differences.

☐ Encourage industry to develop projects using the Kyoto flexibility mechanisms, and indicatively quantify the potential contribution of these projects in achieving the Canadian greenhouse gas emissions target.

Energy Market Reform

☐ Analyse the benefits of deregulated electricity and gas markets as part of the wider North American energy market, as a means of encouraging the further development of freely competitive, regional electricity and gas markets to the retail level. The analysis might include the benefits of retail deregulation, corporatisation versus privatisation, and effective open market arrangements.

☐ Work together with provinces and industry to promote energy market reform on a regional basis and seek provincial agreement to further develop such markets. Consideration might be given to enhancing co-operation mechanisms involving policy officials and regulators, building on existing relationships, to promote interprovincial and international trade in electricity, and to provide advice and analysis of options for individual provinces on issues such as stranded costs, establishment of independent system operators and other necessary industry structure and regulatory mechanisms.

☐ Consider options to address the issues raised by multiple regulators setting and enforcing standards in multiple jurisdictions for the interconnected grid in an increasingly integrated North American market.

☐ Discuss with the provinces the role of consumer protection in deregulated markets, including requirements for the provision of adequate information to consumers to ensure informed choices are made, measures to regulate residential marketing practices, and supply in the last resort.

☐ Discuss with the provinces the harmonisation of domestic electricity market legislation as a means of encouraging a regional approach to investment and market development generally.

☐ Review the adequacy of information on emerging gas transmission capacity requirements with the objective of ensuring timely and efficient expansion of gas infrastructure by private parties.

Nuclear

☐ Review the management of Atomic Energy of Canada Limited, and the rationale for continuing government participation in commercial activities under AECL. A review should aim to:

a) ensure that the Canadian nuclear industry continues to bear the full cost of its activities, unsubsidised by government;

b) take advantage of Canadian expertise by stimulating the development of profit-making private industry from activities currently within AECL;
c) ensure that the government role in nuclear research is clearly defined.

☐ Move quickly to confirm and implement a policy on nuclear waste disposal, and ensure the implementation of the present policy goal of passing the full cost on to the industry.

☐ Ensure that decisions on the future of existing nuclear power plants take into account the greenhouse gas emissions benefits expected from their continued operation.

Renewables

☐ Monitor the impact of energy pricing reform in remote communities to determine its impact on the development of renewables.

☐ As one element in a wider strategy for market reform, seek provincial agreement for the introduction of market-based incentives in market reform policies to encourage the participation of renewables in liberalised markets.

Research and Development

☐ Consider giving further support for research and development related to reducing greenhouse gas emissions by reviewing the level of funding for non-nuclear energy research and development in the context of the magnitude of the task facing the Canadian Government to meet its greenhouse gas emissions target. Consideration should be given to the scope for increased support from government and private sources.

☐ Maintain a minimum level of sustained medium- to long-term research in the non-nuclear programme. Consideration should be given to expanding the role played by government in deployment initiatives as a means of encouraging the use of new technologies.

☐ Consider the benefits of setting priorities and allocating funding for nuclear and non-nuclear research and development budgets through a single process.

Coal

☐ Continue to work towards the sale of the assets of the Cape Breton Development Corporation and its eventual dissolution as a Crown corporation.

☐ Develop a means for establishing genuine competition in rail transport of bulk commodities, including coal.

RÉSUMÉ DES CONCLUSIONS ET RECOMMANDATIONS

RÉSUMÉ

Le fait que le Canada dispose de toutes les formes de ressources énergétiques relativement bon marché a rendu possible le développement d'une économie fondée sur des industries énergivores. Le Canada a pu devenir l'un des fournisseurs d'énergie des États-Unis; il approvisionne l'Asie en charbon et en technologie nucléaire. La répartition des ressources entre les provinces et le partage des compétences sur le secteur de l'énergie ont fait que les schémas de développement de ce secteur et les politiques énergétiques varient considérablement d'une province à l'autre.

L'abondance des ressources du Canada en hydroélectricité et en uranium, conjuguée au développement de la technologie CANDU (réacteurs nucléaires), a favorisé la croissance d'une industrie de l'électricité largement fondée sur des sources d'énergie renouvelables qui émettent peu de carbone.

Politique énergétique générale

Du fait de la séparation des pouvoirs entre le gouvernement fédéral et les gouvernements provinciaux, la politique fédérale encadre le secteur dans son ensemble, mais ne détermine pas les politiques dans tous les domaines. Elle se concentre sur le développement durable et l'efficacité énergétique. La réforme réglementaire des industries de l'électricité et du gaz naturel (à l'exclusion des échanges internationaux et interprovinciaux) a surtout été du ressort des gouvernements provinciaux. La politique est coordonnée par des comités de haut niveau et grâce à des contacts informels entre les gouvernements provinciaux et le gouvernement fédéral. L'industrie nucléaire demeure principalement un domaine de responsabilité du gouvernement fédéral, alors que les gouvernements provinciaux ont dans leur sphère de compétence les droits miniers de la Couronne et la responsabilité constitutionnelle de la gestion et de l'exploitation des ressources. Les politiques énergétiques des gouvernements provinciaux s'intéressent surtout à la gestion des ressources, au développement économique et à l'obtention d'une part équitable de la rente économique, par le biais des redevances. Les gouvernements des territoires, où le gouvernement fédéral a la responsabilité de la mise en valeur des minéraux énergétiques, se concentrent sur le développement économique des ressources.

La responsabilité de la réglementation est partagée entre les gouvernements provinciaux et le gouvernement fédéral. Le gouvernement fédéral est investi de pouvoirs réglementaires importants sur les échanges internationaux et

interprovinciaux, mais, en général, il laisse jouer les forces du marché. La production de l'électricité a longtemps été le monopole de grandes sociétés d'État provinciales, mais cette situation est en train de changer.

La question de la sécurité des approvisionnements énergétiques ne se pose pas, en raison de l'abondance et de la diversité des ressources énergétiques du Canada. Il n'y a encore jamais eu de problèmes; néanmoins, la forte croissance de la production et des exportations de gaz naturel va se poursuivre, et on peut envisager l'exploitation de ressources en gaz naturel dans des régions éloignées. Les marchés ont besoin d'informations fiables pour fonctionner efficacement et les gouvernements jouent un grand rôle, au Canada, dans l'analyse des tendances du marché. Les organismes gouvernementaux devraient s'assurer que les différents intervenants sur le marché disposent de suffisamment d'informations sur les besoins potentiels en installations de distribution de gaz naturel, afin que les intervenants privés puissent développer en temps et lieu les infrastructures nécessaires.

La politique de l'énergie et l'environnement

Le Canada risque d'avoir à supporter des coûts économiques lourds pour atteindre les niveaux d'émissions de gaz à effet de serre auxquels il s'est engagé dans le Protocole de Kyoto, selon les délais et les outils utilisés pour y parvenir. Le Canada a opté de façon générale pour des mesures volontaires doublées de programmes d'information, d'incitatifs financiers et de normes d'efficacité énergétique. Des mesures complémentaires sont en train d'être élaborées pour répondre aux différents besoins des secteurs énergétiques provinciaux. Le gouvernement fédéral s'est engagé à faire en sorte qu'aucune région ne soit obligée de supporter un fardeau indû. Au moment de l'élaboration du cadre de mise en œuvre du Protocole de Kyoto, il faudra que le gouvernement fédéral et les gouvernements territoriaux et provinciaux, ainsi que tous les partenaires, soient capables de démontrer l'efficacité des mesures retenues par le Canada.

D'autres mesures possibles sont actuellement élaborées par des groupes de travail mixtes gouvernement-industrie : les « tables de concertation ». Sans les mesures déjà en place, les émissions du Canada seraient sans doute supérieures d'un tiers à ce qu'elles sont actuellement. Il est probable que le Canada devra appliquer des mesures plus sévères encore pour atteindre son objectif.

Les « tables de concertation » fonctionnent selon un processus de « bas-vers-le-haut », qui devrait aboutir à des propositions utiles et pratiques, nées d'une compréhension et d'une analyse communes à toutes les parties. Dans le cadre de ce processus, le Groupe d'analyse et de modélisation (l'une des tables) a construit le modèle nécessaire à l'analyse des conséquences économiques, environnementales et sociales des différentes voies à suivre pour atteindre l'objectif de Kyoto. Il faudra traduire ce travail en un train cohérent de mesures qui aura l'aval de tous les niveaux de gouvernement. Le gouvernement fédéral devrait continuer à travailler avec les provinces pour parvenir à concevoir une stratégie intégrée de mise en œuvre, fondée

sur l'analyse globale de la tâche à mener. Il devrait encourager le secteur privé à poursuivre des mesures pour réduire les émissions de CO_2 au moindre coût, y compris les mécanismes internationaux de flexibilité, comme la mise en œuvre conjointe, le mécanisme du développement propre et les échanges de droits d'émission. Il devrait essayer de quantifier la contribution de ces mesures dans l'atteinte de l'objectif fixé au Canada.

Efficacité énergétique

L'Office de l'efficacité énergétique est l'unité centrale responsable de la composante efficacité énergétique du Programme d'efficacité et d'énergie de remplacement (EER). Il a restructuré la gestion du programme, désormais fondée sur les produits et les résultats du programme, et sur les performances du marché, ce qui a augmenté la transparence et la responsabilisation. Le recours à des indicateurs désagrégés de l'efficacité énergétique et de l'utilisation de l'énergie, par secteur, ainsi que leur évaluation et leur développement continus sont louables.

Une réglementation exhaustive des appareils et des bâtiments, complétée par un système d'étiquetage, est en place dans le secteur résidentiel et, dans une moindre mesure, dans le secteur commercial. Les normes, les codes et les règlements couvrent une grande partie de la consommation énergétique des ménages et, là où ils ont un caractère obligatoire, ont une bonne pénétration du marché. Si elle est adoptée largement par les provinces, cette approche devrait avoir des effets positifs sur la consommation d'énergie et les émissions de CO_2 malgré une augmentation marquée de la population et des revenus. Les effets seraient moins visibles dans le secteur commercial.

Dans l'industrie et les transports, les mesures d'EER reposent largement sur des campagnes d'information bien ciblées et des mécanismes de persuasion, tels que des engagements volontaires, pour l'adoption de pratiques d'efficacité énergétique. Dans les secteurs où l'on vise un changement des comportements, comme dans les transports, il est peu probable que l'information et les mesures de sensibilisation seules amènent une généralisation des nouvelles pratiques. Dans certains secteurs industriels à tout le moins, les taux d'amélioration d'efficacité ne semblent pas être beaucoup plus élevés que s'il n'y avait pas eu de mesures gouvernementales. Maintenant qu'il dipose d'une information détaillée sur les variations de l'intensité énergétique qui ont eu lieu dans l'industrie, le gouvernement devrait s'efforcer d'encourager des engagements plus fermes s'il veut conserver la philosophie globale de l'action volontaire.

L'adoption de programmes existants et bien conçus pourrait être largement facilitée par l'introduction de mesures complémentaires fondées sur le marché. Chez les utilisateurs finals, il est nécessaire d'intégrer les programmes existants avec de nouvelles mesures fondées sur le marché pour maximiser l'impact des premiers. Le récent programme d'incitation pour les bâtiments commerciaux est un bon exemple de la façon dont on pourrait procéder. Des engagements volontaires plus

rigoureux pourraient être négociés à la place de mesures fiscales ou réglementaires quand on pense que l'industrie risque d'être handicapée par la concurrence.

De nouvelles mesures pour améliorer l'efficacité énergétique émergeront probablement du processus des tables de concertation. Un nouveau renforcement du programme actuel d'efficacité énergétique semble probable. La mise en place d'objectifs indicatifs pour la réduction des émissions par les consommateurs pourrait constituer une première étape qui permettrait ensuite de renforcer davantage les mesures du programme, de les affiner et de leur donner un ordre de priorité.

Les provinces ont la responsabilité d'un grand nombre de domaines ciblés par les programmes fédéraux d'efficacité énergétique. L'efficacité des programmes fédéraux pourrait être compromise par leur adoption incomplète dans les différentes provinces. Une intégration plus poussée des approches suivies par le gouvernement fédéral, les provinces et les municipalités s'accorderait avec l'évolution des marchés concurrentiels de l'énergie.

Réforme des marchés – l'électricité et le gaz naturel

Dans certaines provinces, la réforme du marché de l'électricité a été un vrai succès. Des gouvernements provinciaux ont libéralisé les marchés dans les limites de leur territoire. La libéralisation du marché de l'électricité permet d'atteindre les objectifs provinciaux en matière d'emplois, d'investissements et de bénéfices pour les consommateurs; elle sert également à faciliter l'accès aux marchés américains. La géographie du Canada rend difficile le développement d'un marché national de l'électricité, mais il existe déjà de nombreux échanges et un potentiel considérable de développement de marchés régionaux dans l'axe nord-sud, entre plusieurs provinces et états américains voisins. Les échanges entre provinces ne sont pas réglementés. Les entreprises de service public dans les provinces limitrophes sont libres de se livrer à des transactions commerciales. Le gouvernement fédéral et les gouvernements provinciaux sont d'accord sur un accès ouvert réciproque aux réseaux de transport.

L'opinion de la commission américaine fédérale de réglementation de l'énergie (FERC) a eu beaucoup d'influence sur le développement de la politique canadienne. Il est probable que les marchés concurrentiels continueront de se développer dans certaines provinces, pour créer la concurrence intérieure et pour pouvoir mieux pénétrer les marchés américains. Cela impliquera sans doute que les structures des marchés des provinces devront se conformer, en partie, à la politique de la FERC, malgré certaines objections à l'application extraterritoriale de ses règles (soulevées par le gouvernement de l'Alberta, par exemple). Le rythme de la restructuration est différent d'une province à l'autre, ce qui implique que tous les avantages potentiels de l'efficacité ne seront pas réalisés et que les investissements dans les infrastructures risquent d'être moins qu'optimaux. Les provinces, cependant, se sont mises d'accord sur l'inclusion de clauses d'accès réciproque dans le chapitre sur l'Énergie de l'Accord sur le commerce intérieur. Les organismes de réglementation provinciaux devront

également faciliter les investissements dans les équipements d'interconnexion quand cela sera dans l'intérêt du consommateur. De la même manière, les nouvelles structures de marché devraient augmenter la coopération entre les provinces. Ontario Hydro Services Company, par exemple, qui a hérité, au moment de la restructuration du secteur ontarien de l'électricité, des équipements de transport et de distribution d'Ontario Hydro, s'est engagée à renforcer par tous les moyens possibles les interconnexions avec le Québec. Les politiques dictées par les gouvernements provinciaux peuvent conduire à des problèmes de planification du transport ou de promotion de la réforme des marchés dans les provinces où le potentiel des échanges est limité, particulièrement avec les États-Unis.

La tendance actuelle à l'intégration des marchés américains et de certains marchés provinciaux profitera aux provinces impliquées et devrait, de ce fait, être encouragée. L'objectif devrait être de favoriser la formation de marchés régionaux et internationaux qui soient efficaces. La convergence des marchés provinciaux nécessitera le développement de principes compatibles qui régiront le développement des marchés régionaux naissants. Ainsi, on pourra éviter des coûts de transition élevés et maximiser les gains d'efficacité à long terme.

Ces réflexions concernent également le gaz naturel. Le marché en amont de l'industrie du gaz naturel est totalement libéralisé; certaines provinces commencent à libéraliser le marché en aval. Des problèmes se sont posés initialement dans certains domaines relevant de façon générale de la protection des consommateurs. Ces difficultés pourraient miner la confiance du public face à la réforme de la concurrence et la transition harmonieuse vers une ouverture complète du marché intérieur.

De façon générale, on donne libre cours aux forces du marché, et les interventions sur les marchés de l'énergie sont exceptionnelles. Les organismes de réglementation acceptent les droits de transport librement négociés; la planification de nouvelles infrastructures de transport et l'évaluation globale de la sécurité de l'approvisionnement sont également laissées au marché.

Le pétrole

L'activité de l'industrie du pétrole classique au Canada est en train de se déplacer des zones de production anciennes, dans l'ouest du Canada, aux régions extracôtières de l'est. Il est difficile de prévoir si la production de pétrole classique continuera à augmenter à mesure que ce déplacement se poursuivra. La croissance de la production totale de pétrole dépendra de l'augmentation de la production de bitume et de pétrole synthétique brut à partir des sables bitumineux. Les entreprises qui s'occupent actuellement de l'exploitation et de la valorisation du pétrole des sables bitumineux, sous la houlette de Syncrude et de Suncor, sont capables de produire du brut synthétique léger à un coût fixe relativement élevé, mais à un faible coût variable. À l'inverse de l'exploitation d'un réservoir classique, l'exploitation des sables bitumineux permet de produire à un rythme constant à

partir d'une ressource connue, souvent avec des camions et des pelles. Les producteurs actuels estiment parvenir à la rentabilité à partir d'un prix de 12 $US le baril de pétrole.

Énergie nucléaire

La puissance nucléaire du Canada repose sur la technologie canadienne CANDU. La plupart des réacteurs sont situés en Ontario, où huit d'entre eux ont été fermés pour de longues périodes par suite d'une baisse de rendement. Aucune nouvelle construction de réacteur n'est prévue. La performance nucléaire a une incidence directe sur la politique d'énergie et d'environnement, dans la mesure où des combustibles fossiles sont actuellement utilisés pour compenser la diminution de la production nucléaire.

Un vaste réseau d'activités gouvernementales, résultant de l'origine canadienne de la technologie CANDU, soutient l'industrie nucléaire. Les activités liées au nucléaire trouvent diverses applications dans un grand nombre de secteurs : la médecine, l'industrie, la promotion des exportations, etc. Plusieurs activités nucléaires, dont celles qui ont trait au CANDU, sont actuellement regroupées au sein d'Énergie atomique du Canada limitée (EACL). Si ces activités étaient séparées les unes des autres, il serait plus facile de formuler des priorités pour l'industrie nucléaire en général et pour la recherche-développement. Le rôle du gouvernement dans les activités relevant du nucléaire serait alors mieux défini.

Énergies renouvelables

Les énergies renouvelables, l'hydroélectricité mise à part, joueront un rôle assez faible au Canada à court terme. Il y a pourtant sans doute une place pour d'autres énergies renouvelables – vent, biomasse et photovoltaïque – dans les régions reculées où la connexion aux réseaux n'est pas rentable. La cogénération à petite échelle et les énergies renouvelables pourraient aussi attirer des investisseurs à la recherche de niches sur les marchés déréglementés : l'approvisionnement de pointe, la fourniture de services connexes ou la vente d'« énergie verte » aux consommateurs qui sont prêts à payer plus cher pour une énergie produite à partir de sources renouvelables. Pour un développement plus marqué des énergies renouvelables, il faudrait sans doute qu'intervienne une forme de soutien, public ou autre, de préférence des incitatifs commerciaux qui soient compatibles avec les réformes en cours sur le marché de l'électricité.

Recherche-développement

Les dépenses gouvernementales en R-D ont subi une refonte majeure par suite des restrictions budgétaires et des nouvelles priorités du gouvernement. Cela a eu pour résultat d'améliorer la transparence et la responsabilisation dans les dépenses en R-D non nucléaire du gouvernement fédéral. Ces programmes sont gérés de façon

efficace et peuvent répondre avec souplesse aux priorités du gouvernement, entre autres à celle actuellement accordée à la réduction des émissions de gaz à effet de serre. Le niveau de coordination avec les partenaires industriels est très élevé. Les fortes réductions des budgets de R-D sont inquiétantes quand on sait combien intensive est l'utilisation de l'énergie dans l'économie canadienne et quand on connaît le défi que représente la réduction des émissions de gaz à effet de serre. Le niveau actuel d'aide à la recherche non nucléaire devrait être revu, et des solutions mises au point pour augmenter les budgets.

Les programmes devraient continuer à reconnaître l'importance des projets à moyen et à long terme. Les compressions budgétaires ont eu pour effet de concentrer la R-D non nucléaire gouvernementale dans des domaines où des fonds de contrepartie peuvent être obtenus de l'industrie. Les initiatives du secteur privé peuvent améliorer l'utilisation et la diffusion des résultats des programmes de R-D, et l'intégration de la R-D gouvernementale avec celle du secteur privé est recommandable. Mais la R-D à moyen et à long terme n'intéresse pas forcément les industriels. Si le financement augmente à nouveau, il faudrait envisager de donner plus d'argent à la R-D à moyen et long terme, et de reconsidérer le rôle du gouvernement dans sa diffusion.

Il pourrait être utile de réexaminer les dépenses gouvernementales en R-D nucléaire, à la manière de ce qui a été fait dans le domaine du non-nucléaire pour fixer les priorités et les procédures de dépenses. Les priorités de la R-D nucléaire sont établies d'une façon différente de celle utilisée pour les programmes non nucléaires. Vu la faiblesse des budgets globaux de R-D, il est vital que les priorités soient évaluées avec le plus grand soin. Il serait utile que les budgets actuels de R-D nucléaire et non nucléaire soient traités en priorité et intégrés globalement dans les objectifs gouvernementaux en un seul processus.

Les industries des ressources énergétiques

Le Canada est un grand producteur et exportateur d'énergie. Les réformes des politiques ont réduit l'influence gouvernementale dans les industries extractives. La réforme micro-économique visant à diminuer les coûts de transport et à augmenter la productivité de la main-d'œuvre restera importante.

Des politiques industrielles plus larges, qui n'entrent pas dans le champ de cette étude, joueront un rôle primordial dans le maintien de la viabilité des industries canadiennes des ressources énergétiques. En ce qui concerne l'industrie du charbon, il serait souhaitable de créer un système de transport ferroviaire qui soit compétitif. Le gouvernement fédéral subventionne depuis plus de 30 ans la production de charbon à la Société de développement du Cap-Breton (CBDC), société de la Couronne. En 1999, le gouvernement a décidé de privatiser les activités de CBDC, une action qu'il a présentée comme la meilleure solution de viabilité commerciale à long terme. Une loi a été déposée pour permettre la privatisation des biens de CBDC.

RECOMMANDATIONS

Le gouvernement du Canada devrait :

Efficacité énergétique

☐ Envisager de définir des objectifs clairs, si possible quantifiés, pour la réduction des émissions de gaz à effet de serre à travers les politiques et les programmes visant les consommateurs.

☐ Renforcer les engagements pris dans le cadre des accords volontaires avec l'industrie.

☐ Resserrer les relations entre les programmes provinciaux et fédéraux d'efficacité énergétique, et aider les provinces qui le souhaitent à élaborer des politiques et des programmes d'efficacité énergétique.

☐ Envisager le renforcement et l'intégration des programmes sectoriels actuels avec des incitatifs économiques, afin de maximiser l'adoption de pratiques d'efficacité.

Énergie-environnement

☐ S'assurer, en accord avec les politiques actuelles, que les éventuelles mesures de lutte contre les émissions de gaz à effet de serre soient adoptées en priorité en fonction de leur coût-efficacité pour l'ensemble du pays.

☐ Exploiter le travail du Groupe d'analyse et de modélisation (effectué dans le cadre du processus des tables de concertation) afin de développer un train cohérent de mesures qui permette d'atteindre l'objectif fixé au Canada pour les émissions de gaz à effet de serre; un accord devrait être conclu rapidement à tous les niveaux de gouvernement sur un ensemble définitif de mesures.

☐ Contrôler les progrès accomplis pour atteindre la part des réductions d'émissions de gaz à effet de serre du Canada attribuée à chacune des mesures.

☐ Envisager les conséquences économiques de ces mesures sur une base régionale, afin de déterminer les efforts des régions selon des critères économiques équitables. Un système national d'échange de droits d'émission pourrait aider à égaliser les coûts marginaux et devrait aplanir les disparités régionales.

☐ Encourager l'industrie à concevoir des projets utilisant les mécanismes de flexibilité de Kyoto, et quantifier à titre indicatif la contribution potentielle de ces projets à l'atteinte de l'objectif du Canada en matière d'émissions de gaz à effet de serre.

Réforme du marché de l'énergie

☐ Analyser les avantages de marchés déréglementés de l'électricité et du gaz naturel intégrés dans un marché nord-américain plus large, et voir dans quelle mesure cela peut encourager le développement de marchés régionaux concurrentiels de l'électricité et du gaz naturel au niveau des détaillants. Cette analyse pourrait détailler les avantages d'une déréglementation de la vente au détail, de la « corporatisation » par rapport à la privatisation, et d'un libre marché.

☐ Collaborer avec les provinces et les industriels à promouvoir la réforme du marché de l'énergie sur une base régionale, et chercher à obtenir l'accord des provinces pour le développement de tels marchés. On pourrait songer à améliorer les mécanismes de coopération entre les responsables des politiques et les organismes de réglementation, en tirant profit des relations existantes, afin de promouvoir le commerce interprovincial et international de l'électricité, et de fournir aux provinces conseils et analyses sur leurs options face à des problèmes tels que les coûts échoués, l'établissement d'exploitants de systèmes indépendants, les autres structures industrielles et mécanismes de réglementation nécessaires.

☐ Envisager des solutions au problème de la pluralité des organismes de réglementation qui définissent et font appliquer des normes d'interconnexion de réseau dans un grand nombre de territoires et dans un marché nord-américain de plus en plus intégré.

☐ Discuter avec les provinces du rôle de la protection des consommateurs dans les marchés déréglementés, y compris les obligations de fournir une information pertinente aux consommateurs afin qu'ils puissent choisir en connaissance de cause; des mesures pour réglementer les pratiques de commercialisation dans le secteur résidentiel; et, en dernier ressort, de l'offre en tant que telle.

☐ Discuter avec les provinces de l'harmonisation de la législation du marché intérieur de l'électricité; cela devrait servir de moyen d'encourager une approche régionale de l'investissement et du développement du marché en général.

☐ Examiner s'il y a suffisamment d'information disponible sur les besoins en nouvelles installations de distribution de gaz naturel, afin d'assurer un développement rapide et efficace des infrastructures de gaz naturel par le secteur privé.

Énergie nucléaire

☐ Examiner la gestion d'Énergie atomique du Canada limitée (EACL) et le bien-fondé du maintien de la participation gouvernementale dans ses activités commerciales. Cet examen devrait chercher à :

a) S'assurer que l'industrie nucléaire canadienne continue à assumer le coût total de ses activités, sans subventions gouvernementales;
b) Profiter de l'expertise canadienne en stimulant le développement d'une industrie privée à but lucratif à partir des activités qui relèvent actuellement d'EACL;
c) S'assurer que le rôle du gouvernement dans la recherche nucléaire est clairement défini.

☐ Prendre des mesures rapidement pour confirmer et mettre en place une politique de gestion des déchets nucléaires; garantir la mise en œuvre de l'objectif de la politique actuelle qui consiste à transférer tous les coûts à l'industrie.

☐ S'assurer que les décisions sur l'avenir des centrales nucléaires existantes tiennent compte des avantages qu'il y aurait à les maintenir en fonctionnement du point de vue des émissions de gaz à effet de serre.

Énergies renouvelables

☐ Contrôler l'impact de la réforme des prix de l'énergie sur les communautés isolées et déterminer ses conséquences pour la mise en valeur des énergies renouvelables.

☐ Chercher, dans le cadre d'une stratégie plus large de réforme du marché, à obtenir l'accord des provinces sur l'introduction d'incitatifs commerciaux dans les politiques de réforme du marché pour augmenter la part des énergies renouvelables dans les marchés libéralisés.

Recherche-développement

☐ Envisager d'augmenter les budgets de la recherche-développement liée à la réduction des émissions de gaz à effet de serre; dans ce but, examiner le niveau de financement de la R-D non nucléaire dans le contexte de l'immense tâche qui attend le gouvernement canadien pour atteindre son objectif de réduction des émissions de gaz à effet de serre. Il faut examiner les possibilités d'un accroissement de la participation financière du gouvernement et du secteur privé.

☐ Maintenir un niveau minimal de R-D soutenue à moyen et à long terme dans le programme non nucléaire. Il faut envisager d'augmenter le rôle du gouvernement dans les initiatives de déploiement pour encourager le recours à de nouvelles technologies.

☐ Envisager les avantages qu'il y a à fixer des priorités et à allouer des fonds à la R-D nucléaire et non nucléaire en un seul processus.

Charbon

☐ Poursuivre les démarches entreprises pour vendre l'actif de la Société de développement du Cap-Breton et, par la suite, dissoudre cette société de la Couronne.

☐ Trouver un moyen d'introduire une véritable concurrence dans le transport ferroviaire des produits en vrac, dont le charbon.

2

CONDUCT OF THE REVIEW

REVIEW TEAM

The 2000 International Energy Agency (IEA) in-depth review of the energy policies of Canada was undertaken by a team of energy policy specialists drawn from the Member countries of the IEA, which visited Canada from 23 November to 3 December 1999 for discussions with government officials, energy suppliers and energy consumers in Ottawa, Calgary, Toronto and Montréal. Information provided during the visit has been supplemented by published sources and IEA statistical analysis of data provided by the Department of Natural Resources, Canada.

Members of the team were:

Hugo E. Brouwer (team leader)
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Department of Energy
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Australia

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Energy Technology Office
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Desk Officer – Canada, Country Studies Division
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John Cameron managed the review and drafted the report, except for Chapters 5 and 8, which were drafted by Michael Landwehr. Monica Petit and Bertrand Sadin prepared the figures.

The team held discussions with the following organisations:

Alberta Department of Resource Development
Alberta Energy Utilities Board
Association of Major Power Consumers of Ontario
Atomic Energy of Canada Limited – Chalk River Nuclear Laboratories
Canadian Association of Petroleum Producers
Canadian Energy Research Institute
Canadian Gas Association
Canadian Nuclear Association
Canadian Wind Energy Association
Coal Association of Canada
Hydro Québec
Independent Electricity Market Operator, Ontario
Ministère des Ressources naturelles du Québec
National Energy Board
Natural Resources Canada (including Canada Centre for Mineral and Energy Technology, CANMET)
Newfoundland Department of Mines and Energy
Ontario Ministry of Energy, Science and Technology
Ontario Power Generation
Suncor
TransCanada Pipelines

The assistance and co-operation of all participants in the review are gratefully acknowledged.

REVIEW CRITERIA

The *Shared Goals* of the IEA, which were adopted by IEA Ministers at their 4 June 1993 meeting, held in Paris, provide the evaluation criteria for in-depth reviews conducted by the Agency. The *Shared Goals* are set out in Annex B.

3

GENERAL ENERGY POLICY

BACKGROUND

Canada is a federation of ten provinces and three territories[1]. Canada is a constitutional monarchy. The Parliament of Canada, in the capital Ottawa, consists of the elected House of Commons and the appointed Senate.

Canada is the largest of the OECD countries (nearly 10 million square kilometres) and the second largest country by area in the world. Canada has a population of about 30 million and a labour force of over 15 million (1998 data). The rate of population growth in Canada during the 1990s has been the highest of all G-7 industrialised countries. Canada's population is projected to increase to about 37 million by the year 2020. Over three-quarters of the total population live in cities and nearly one-third of the population live in the three largest cities of Toronto, Montréal and Vancouver. Canada has the sixth highest standard of living in the world.

The Canadian economy has grown strongly over the 1990s. Growth in gross domestic product reached 3.0% in 1998, after falling back in 1995 and 1996 from a peak of over 4% in 1994. Exports account for over one-third of gross domestic product and private consumption is growing at about 5% per year. Economic growth by regions varies substantially. In the period 1990 to 1997, the average annual growth rate for Canada as a whole was 1.8%, varying from 0.9% in the Atlantic region to 3.2% in Alberta. Energy investments were important for growth in Alberta and the Atlantic region, particularly Newfoundland and Nova Scotia. Projections prepared by Natural Resources Canada assume an annual rate of growth in the economy of 2.4% from 1997 to 2020.

GENERAL ENERGY POLICY

Responsibility for energy policy is divided between the provinces and the federal government both geographically and functionally. The federal government also has responsibilities similar to provincial responsibilities in the territories and in offshore development. It has concurrent powers in Frontier Lands Accord Areas[2]. The negotiation of international trade agreements is within federal jurisdiction, but the provinces are responsible for implementation in areas of their constitutional responsibility. Interprovincial trade and international trade are federal responsibilities, but the provinces are influential in both. The following summarises the principal divisions of responsibility.

1. Alberta, British Columbia, Prince Edward Island, Manitoba, New Brunswick, Nova Scotia, Ontario, Québec, Saskatchewan, Newfoundland, Northwest Territories,Yukon Territory and Nunavut. Nunavut was created on 1 April 1999.
2. Accord areas are broadly offshore Labrador, Newfoundland, offshore Newfoundland, and offshore Nova Scotia. Non-Accord areas are broadly Yukon Territory, Northwest Territories, Hudson Bay, Nunavut and waters surrounding Nunavut.

Figure 2
Federal Energy Structure

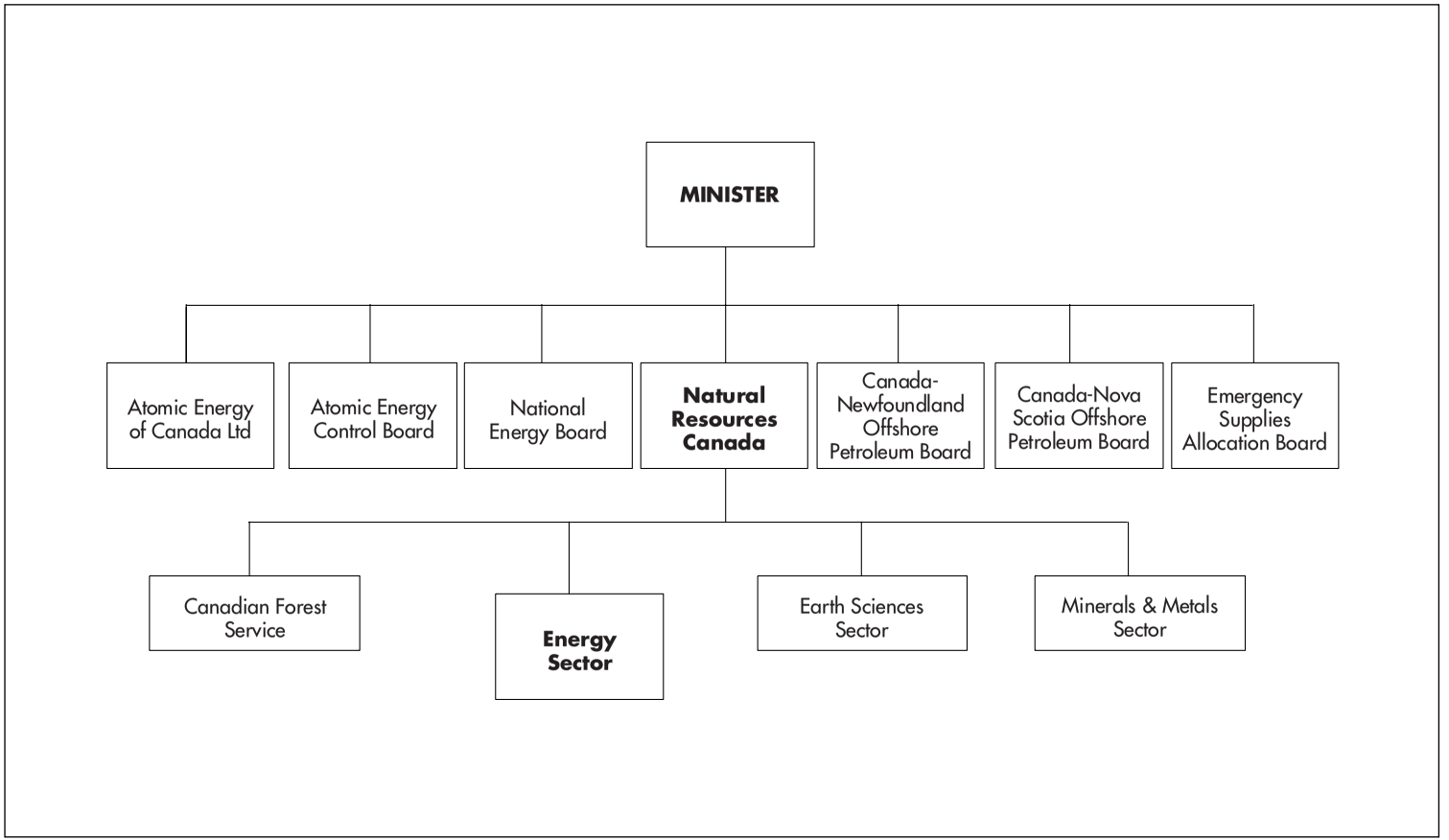


Table 1
Division of Responsibilities for Energy Policy

Provincial Governments	*Federal Government*
• Development and management of resources within provincial boundaries. • Property and civil rights within the province, i.e., environmental, health, safety, land use, consumer protection, etc. • Regulation and legislative framework for electricity and natural gas including in many cases ownership of Crown corporations engaged in these activities. • Secure appropriate economic rent as resource owner from Crown mineral rights. • Policies in the provincial interests, such as economic development, and energy science and technology.	• Resource management on non-Accord Frontier Lands. • Uranium/nuclear power. • Interprovincial/international trade and commerce. • Interprovincial works and undertakings. • Trans-boundary environmental impacts. • Policies in the national interest: – economic development, – energy security, – federal energy science and technology.

The administration of federal energy policy is illustrated in Figure 2.

Energy policy has the following principal objectives:

- Competitive and innovative energy sector.
- Environmental stewardship
- Energy security – supply, reliability, health and safety.
- Receiving fair economic rent from mineral rights ownership.
- Economic development.

Objectives are achieved by a combination of market-oriented broad framework policies (ensuring a level playing field through the fiscal regime, market access through trade and investment liberalisation, and market efficiency through interprovincial trade), and selective focused interventions (in the areas of nuclear energy, regulation, research and development, energy efficiency, alternative transportation fuels, and renewables). Federal energy policy takes place within three major energy arenas: conventional energy supply, climate change and air quality issues, and nuclear.

Conventional Energy Sources

Policy on oil and gas markets (Chapter 7) is strongly market-focused. Offshore management for east coast oil and gas is an important area of activity for the federal

government. Electricity market reform and industry restructuring (Chapter 6) are key issues, but primarily a provincial domain.

Climate Change

Policies to meet Canada's greenhouse gas emissions target are a major focus of federal policy. There are three broad areas of policy employed to achieve this goal: energy efficiency (Chapter 5), renewable energy strategy (Chapter 6), and science and technology (Chapter 8). There are five categories of energy efficiency programmes: information/suasion programmes (e.g., provision of consumer information), voluntary programmes, regulation (e.g., equipment efficiency standards), financial incentives for innovation, and research and development.

Nuclear

Canada is the world's largest producer of uranium. Nuclear power plays an important part in electricity generation. The federal government has jurisdiction over the whole nuclear fuel cycle. Nuclear power in Canada (Chapter 6) is going through a transition period as a result of market deregulation, ageing nuclear plants, and the absence of new domestic orders. In Ontario, particular problems arising from failing performance attributed to management have led to shut-downs.

Canada is seeking to modernise its nuclear regime, for example through the new Canadian Nuclear Safety Act and regulations, and to settle a policy for the long-term management of radioactive wastes.

ENERGY SUPPLY[3] AND DEMAND

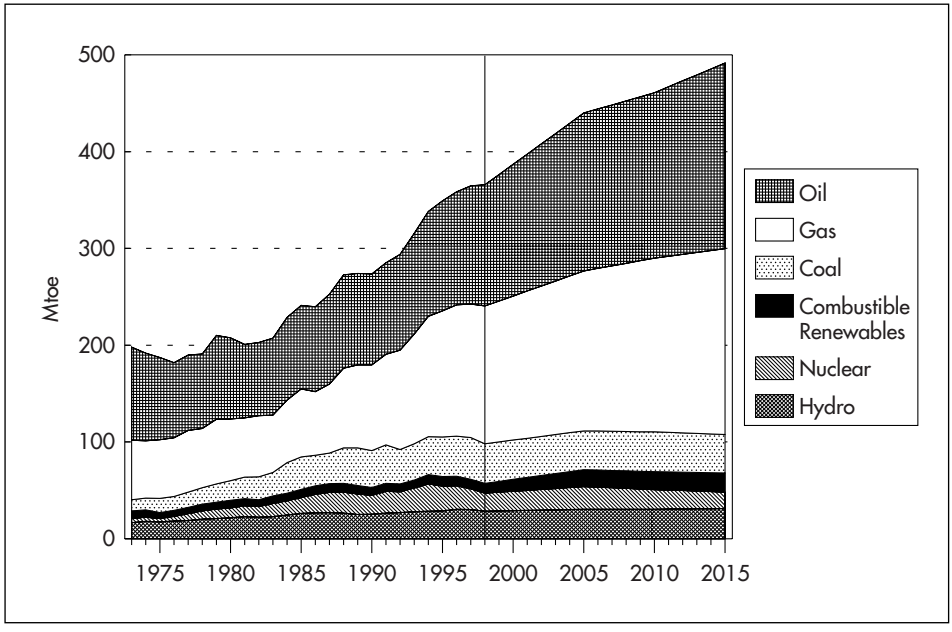
Primary Energy Supply

Annex A contains information on Canada's energy balances and key statistical data. Canada is a net exporter of all energy materials. Oil and gas account for about one-third each of total energy supply, and coal and uranium account for most of the remainder. About three-quarters of Canada's energy supplies are from fossil fuels.

A growing proportion of Canada's petroleum production is from bitumen and oil sands. Reserves of both these categories far exceed reserves of conventional oil,

3. See footnotes to Energy Balances and Key Statistical Data (Annex A). Combustible renewables comprise solid biomass and animal products, gas/liquids from biomass, industrial waste and municipal waste. Hydro is classified separately from "renewables".

Figure 3
Energy Production, 1973-2015



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1999, and country submission.

and the production of oil from these sources is expected to grow dramatically, even if oil prices are low.

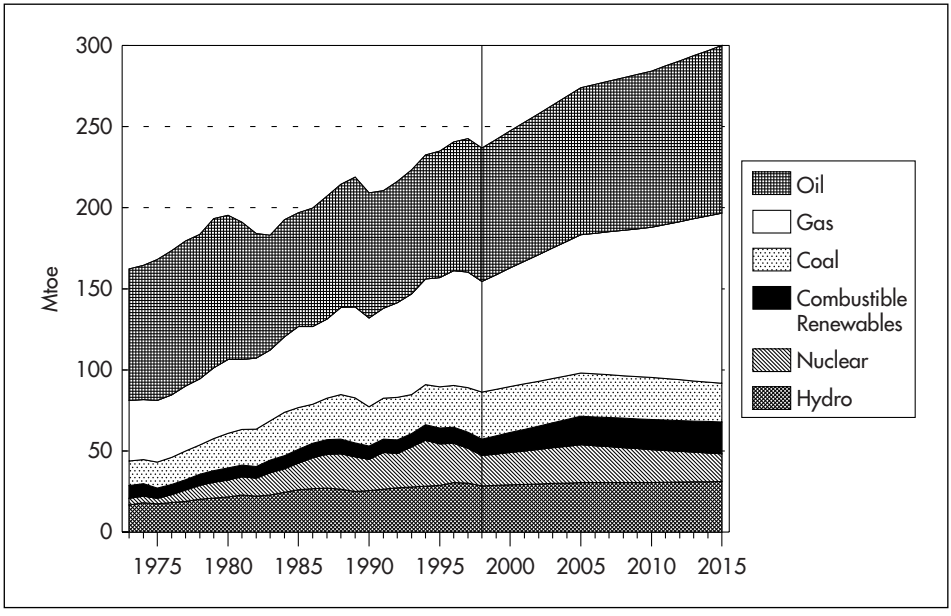
Primary energy supply is illustrated in Figure 4. Coal, as a percentage of energy consumption in Canada, has fallen dramatically from 1945, recovering only slightly after the oil crises of the 1970s. It has been stable since the mid-1980s. Petroleum, as a percentage of total consumption, has fallen steadily from 1960 (faster after the 1979 oil shock) and has been stable since the mid-1980s. Gas, as a percentage of total consumption, has risen steadily since 1955 and similarly for hydro from 1935 and nuclear from the early 1970s (falling off with the reactor closures commencing in 1997).

Final Energy Consumption

Total final energy consumption in 1998 was 182.5 Mtoe, a decrease of 1.4% from 1997, and about one-half the rate of growth in gross domestic product. In 1998, oil accounted for 43.8% of final consumption, gas 27.3%, electricity 21.5%, renewables (excluding hydro) 5.2% and coal 1.8%.

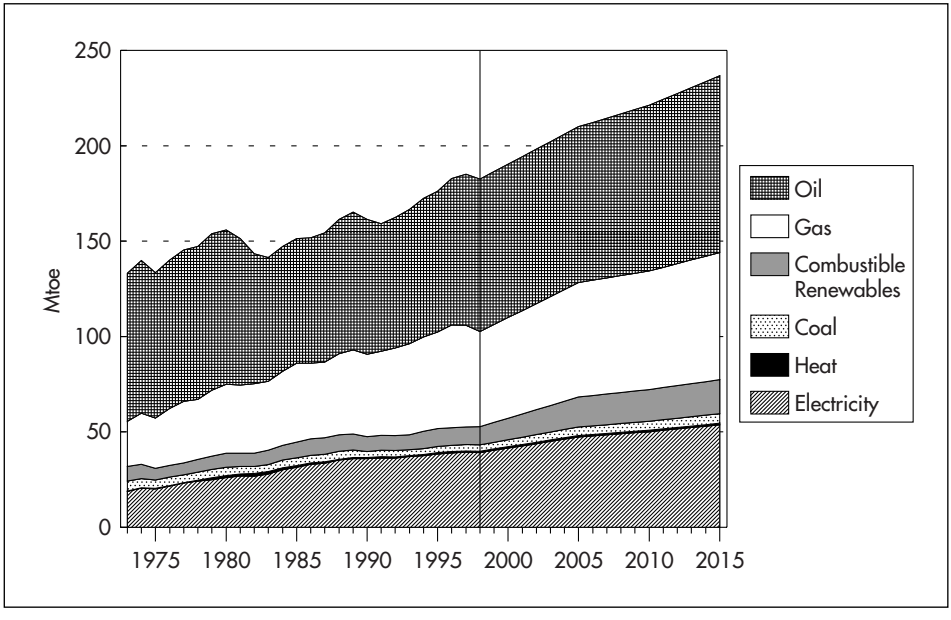
In 1998, industry accounted for about 40% of final energy consumption, and transport accounted for about 29%. Since 1990, transport demand for energy has risen by nearly 20%, and industrial demand has risen by nearly 46%.

Figure 4
Primary Energy Supply, 1973-2015



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1999, and country submission.

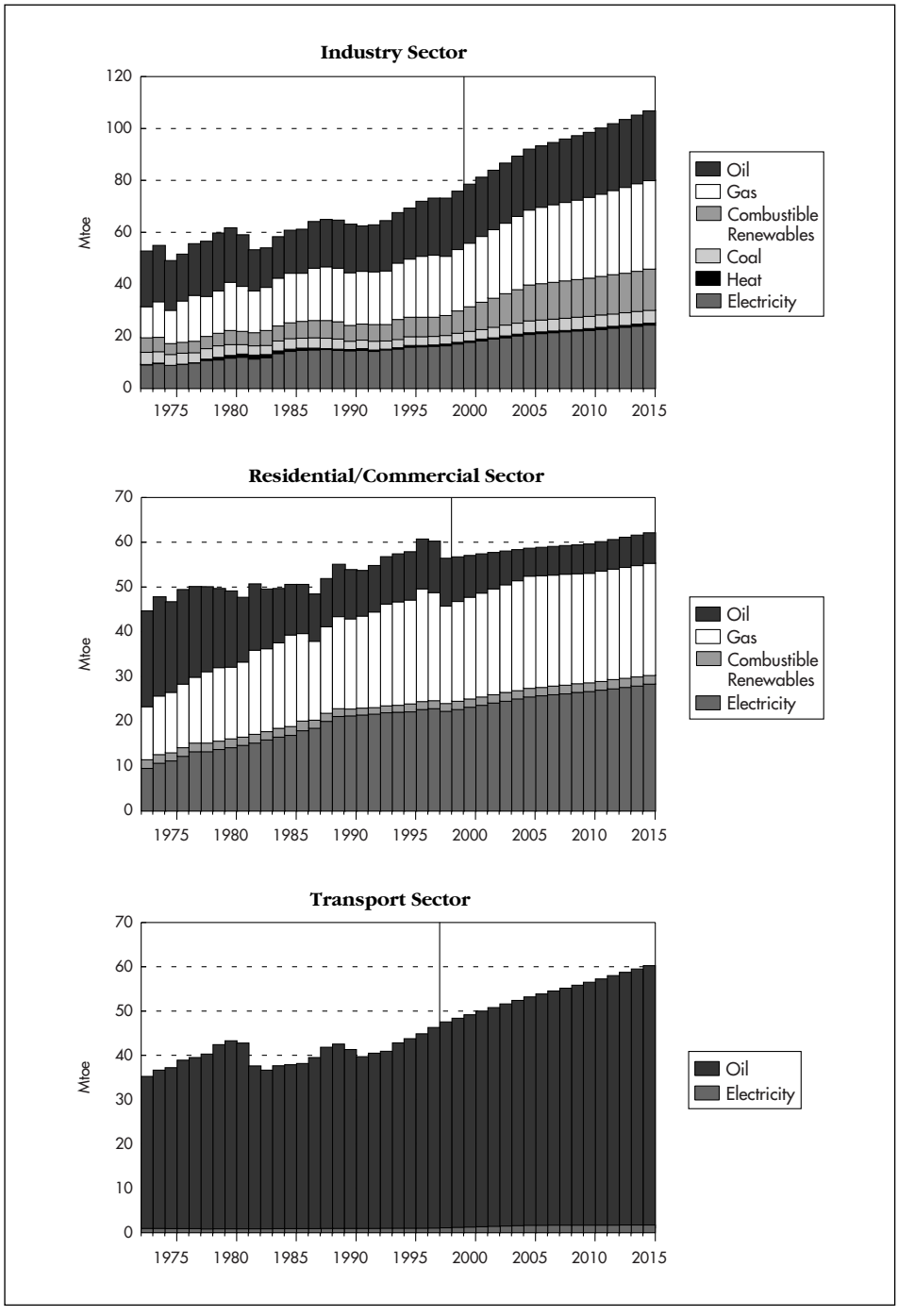
Figure 5
Total Final Consumption by Fuel, 1973-2015



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1999, and country submission.

Figure 6

Final Consumption by Sector and by Fuel, 1973-2015



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1999, and country submission.

Energy Taxation

A federal Goods and Services Tax (GST) of 7% applies to all energy. GST is a value-added tax and hence is rebated for all but domestic consumption. Provincial taxes may apply in some cases. Federal excise tax and provincial sales taxes apply to automotive diesel oil, and gasoline. A federal Gasoline Sales Tax also applies. Total federal excise taxes amount to about 10 (Canadian) cents per litre of gasoline and 4 cents per litre of diesel. Provincial sales taxes vary between 6 cents and 16 cents per litre, depending on the province.

CRITIQUE

The major influences on policy are Canada's resource endowment, the federal system of government and integration of the North American economy.

There are three fundamental influences on Canadian energy policy: Canada's large and diverse natural resource endowment, the federal system of government, and the integration of the Canadian and US economies. The division of powers between different levels of government gives rise to a political culture that values consensus building as a means of responding to new challenges. These themes emerge in almost every aspect of Canadian energy policy reviewed in this report. As in other IEA countries, the dominant issues for energy policy are meeting national commitments on reducing greenhouse gases, and regulatory reform of the electricity and gas industries to reduce energy costs and expand trade.

The resource endowment has led to the development of trade in energy, energy commodities, and energy technology (notably CANDU nuclear technology). It has also led to the development of highly efficient and productive industries exploiting, or based on, fossil fuels. Like other open economies with a high external exposure, Canada must balance economic and environmental interests to ensure its commitments on climate policy are met at minimal economic cost. There are marked differences in the resource endowment, and hence the structure of energy demand and supply, between the provinces. For example, fossil fuel production is concentrated in Alberta and is of major importance to the provincial economy; nuclear production is concentrated in Ontario; hydro production is important in a number of provinces, but notably in Québec. These diversities and the constitutional division of powers over energy issues create challenges for the federal government in implementing a national approach to energy policy.

In Canada, the provinces assert the constitutional division of powers perhaps more strongly than in other federal systems (such as the US and Australia). Change in the government's role in the energy economy generally, and specifically in the electricity industry, has been led by provincial governments (notably Alberta and Ontario) seeking to reduce energy costs to industry and to take advantage of the liberalised US electricity and gas markets.

Three issues recur regularly in IEA reviews: energy security, energy-environment, and regulatory reform of the energy sector. The following paragraphs comment on each of these issues in relation to Canada.

Physical energy security is not an issue but planning supply infrastructure is a consideration.

Physical energy security is not an issue in Canada because of its huge and diverse energy resource base. Although no problems have arisen to date, strong growth in gas production and exports will continue and there is potential for developing gas resources in remote locations. Markets require good information to operate effectively and governments in Canada play an important role in analysing market trends. Government agencies should ensure that market players are receiving adequate information on emerging gas transmission capacity requirements to ensure the timely and efficient expansion of gas infrastructure by private parties. This issue is taken up in Chapter 7.

Climate issues and energy efficiency are priorities for the federal government.

Canada's energy policy is strongly market-oriented and change is occurring rapidly. The focus of this report is on federal policies, where priority is currently given to energy-environment policy and energy efficiency. The effectiveness of these policies will be tested in the period up to 2008-2012 in which Canada must achieve its target for reducing greenhouse gases. The federal government's most pressing policy objective is to settle a package of policies and measures (including on energy efficiency) which will achieve the target. The Government of Canada is confident that an adequate package will be agreed in time based on the Tables process described in Chapter 4. While the process appears slow and complex, it is modelled on processes used in other areas of environmental policy where successful outcomes have been recorded. The resulting package is likely to rely on co-operation between stakeholders, rather than mandatory regulation or legislation. The federal government will play a central role in gaining the commitment of the provinces and stakeholders to achieving the greenhouse target, and in monitoring and adjusting progress in the short period leading up to the commitment period.

Regulatory reform is principally a provincial matter.

Regulatory reform is of lesser priority for the federal government because provincial governments have jurisdiction in the remaining areas requiring reform. Change in this area of policy has been rapid but uneven. The oil and coal industries and the upstream gas industry are largely free of government involvement and are highly competitive, nation-wide. The downstream gas market is completely open in Ontario and is opening in a few other provinces, but slowly. The electricity-generating industry is opening rapidly in some provinces, but is under close regulation in others. The principal drivers for change are the rapidly evolving competitive markets in the US for electricity and gas, and industrial consumer pressure for lower domestic energy costs. Rapid change is likely to continue, with marked unevenness of progress between the provinces. The federal government has a monitoring role to ensure a favourable outcome for the economy generally and for domestic energy consumers in particular. Whether a more proactive role is required is discussed in Chapter 6.

4

ENERGY AND THE ENVIRONMENT

KYOTO COMMITMENTS

Under the Kyoto Protocol of December 1997, Canada is committed to bringing its overall emissions of greenhouse gases[4] to 6% below the 1990 level of 601 Mt. The target is to be reached during the period 2008-2012. In December 1997, Canada's first ministers set out a framework for further progress on climate change that included achieving a thorough understanding of the costs and benefits of the protocol's implementation and the various implementation options open to Canada.

Environment Canada and the Department of Foreign Affairs and International Trade co-lead the international climate change negotiations. Natural Resources Canada is the lead department for the domestic implementation of measures to meet the Kyoto commitments. A federal climate change secretariat reports to the deputy ministers of Natural Resources Canada and Environment Canada. The National Climate Change Secretariat has been established as a federal-provincial body to co-ordinate the efforts of the provinces and territories, of the private sector, and of other stakeholders in developing responses to climate change.

ENERGY SECTOR EMISSIONS

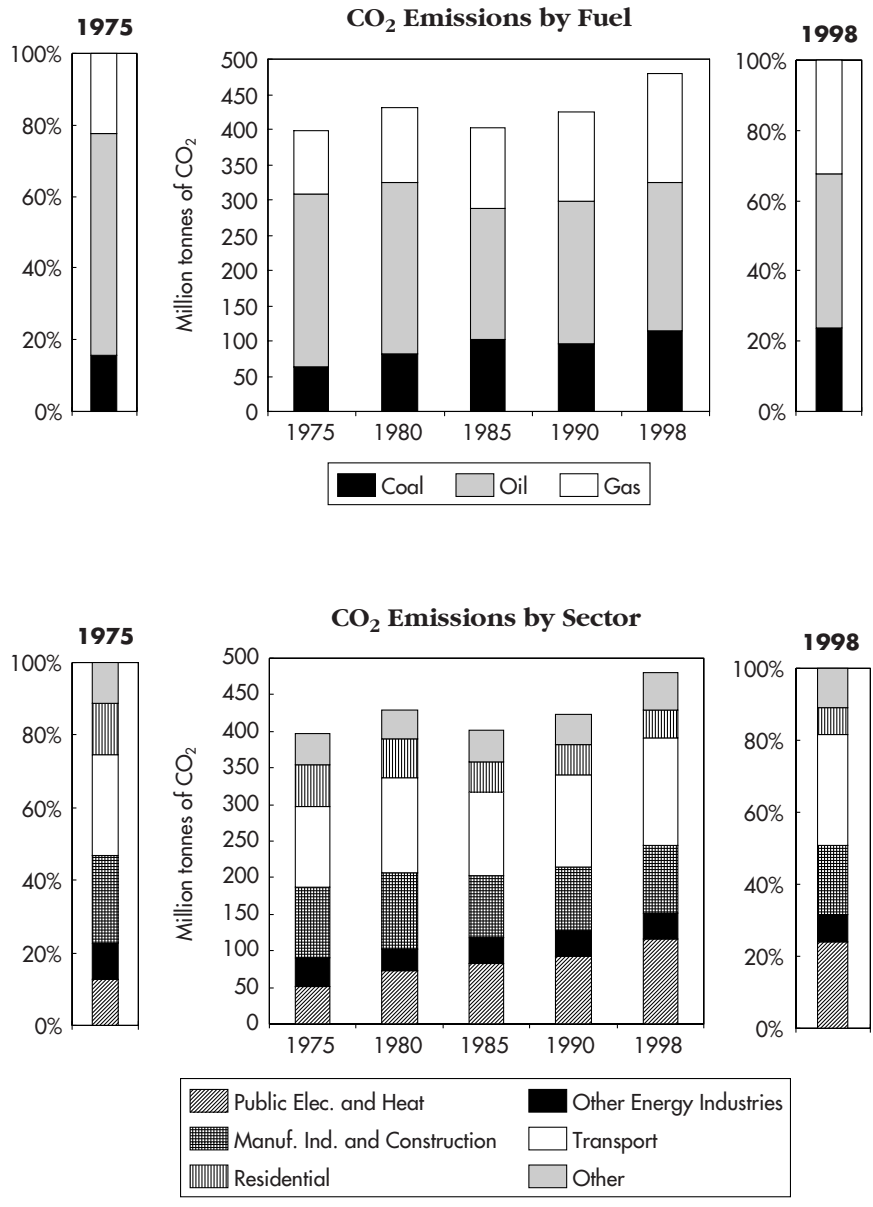
Carbon dioxide emissions by sector and by fuel are illustrated in Figure 7. Emissions associated with energy use account for about 90% of Canada's greenhouse gas emissions. Canadian emission increases are driven by North American demand for energy commodities. As with other energy commodity exporting countries, accounting for full cycle emissions is an issue since the focus of attention tends to be on upstream-related emissions.

From 1990 to 1997, greenhouse gas emissions in Canada grew by 13%. The largest source is the transport sector. Emissions from the industrial sector are also expected to grow despite some improvements in energy intensity. Emissions from the commercial sector are expected to remain constant while emissions from the residential sector are expected to show a decline.

4 Gases that contribute to the warming of the earth's surface. The Kyoto Protocol (December 1997) defines commitments to reduce emissions of the following six greenhouse gases: CO_2 (carbon dioxide), CH_4 (methane), N_2O (nitrous oxide), HFCs (hydrofluorocarbons), PFCs (perfluorocarbons), and SF_6 (sulphur hexafluoride). On a global level, CO_2 is the single most important anthropogenic greenhouse gas. Fossil fuel production and use represent about three-quarters of CO_2 emissions from human activity. Other energy-related greenhouse gases include CH_4 from the production, transportation and use of natural gas and coal, and N_2O primarily from fuel wood use. The three other greenhouse gases covered by the Kyoto Protocol are not energy-related: HFCs (used as alternatives to ozone-depleting substances, such as coolants), PFCs (from aluminium smelters), and SF_6 (used in insulators for electrical transmission and distribution systems).

Figure 7

Carbon Dioxide Emissions by Fuel and by Sector, 1975-1998



For presentational purposes, the statistical difference and the differences due to losses and/or transformation have been allocated between the sectors.

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 1999.

Over 75% of Canada's electricity is currently generated by non-emitting sources, principally hydro and nuclear power, but also biomass and renewables. Of the greenhouse gas emitting sources, coal (17.4% of electricity production and over 80% of emissions) accounts for the largest component, followed by natural gas (4.1% of electricity production and about 10% of emissions) and oil (about 2% of electricity production).

Carbon dioxide emissions from fossil fuel production, largely related to natural gas and oil sands production, are expected to account for about 12% of total emissions in 2000. Production in these areas is expected to triple in the period 1995-2010 and to grow fourfold by 2020. Synthetic crude is estimated to have produced carbon dioxide emissions of 117.8 kg per barrel in 1995, but emissions are expected to decline to 82.5 kg per barrel by 2010. Emissions from production of bitumen and conventional crude will remain steady at 69.8 kg per barrel for bitumen and 23.2 kg per barrel from conventional crude oil.

CURRENT RESPONSE MEASURES

The National Action Program on Climate Change launched in 1995 governs Canada's national effort on climate change. The National Action Program on Climate Change includes federal, provincial and municipal initiatives already announced, or likely to be announced, that focus on energy efficiency, alternative energy, and reductions of greenhouse gas emissions. Some provinces have also taken action with stakeholders in their own jurisdictions.

An important component of the National Action Program on Climate Change are voluntary undertakings (for example, by industry) registered with Canada's Voluntary Challenge & Registry Inc[5]. The Climate Change Voluntary Challenge and Registry was established in 1994 and privatised in October 1997. The organisation registers voluntary commitments to reduce greenhouse gas emissions. More than 850 organisations, including federal and provincial government bodies, have registered. Over one-half of these have submitted action plans, and almost one-fifth have submitted annual progress reports. Registered organisations are estimated to account for over 60% of Canada's greenhouse gas emissions.

Specific federal activities include:

- Creation of the Office of Energy Efficiency within Natural Resources Canada to strengthen the impact of energy efficiency programmes.

- The Climate Change Action Fund, announced in the 1998 Budget, with an initial commitment of C$ 150 million over three years to lay the foundation for longer-

5 The Internet site for Voluntary Challenge & Registry Inc. is www.vcr-mvr.ca

term solutions, to support federal co-operation with all other public/private sector partners, and to launch an information campaign to promote early action. Expenditure by Natural Resources Canada under other programmes which also address climate change (energy efficiency programmes, research and development investment, renewable energy programmes) is approximately C$ 100 million annually.

- Increasing awareness of the climate change issue through the Public Education and Outreach component of the Climate Change Action Fund. In early 1999, fifteen projects were approved and twenty projects were undergoing approval. This measure has funding of C$ 30 million over three years.

- Municipal energy efficiency retrofit programme to be funded by Natural Resources Canada and operated by the Federation of Canadian Municipalities (announced in the 1999 Budget). The programme will be supported with funding of C$ 1.6 million over three years.

- A strategy to enhance the role of renewable energy.

- Technology Early Action Measures to promote greenhouse gas emissions reduction technologies (for example, ethanol fuel and fuel cells). In early 1999, seventeen projects had been allocated funding from the Climate Change Action Fund. The total value of all projects is approximately C$ 147 million.

- Tax incentive to reduce gas flaring in oil production.

- A requirement for federal departments to develop baseline data and forecasts on their greenhouse gas emissions, in order to prepare targets for reducing greenhouse gas emissions from their own operations and to prepare mechanisms for monitoring their achievement.

DEVELOPMENT OF FURTHER RESPONSE OPTIONS

Together with the provinces, territories and municipal governments and various stakeholders (including private sector and environmental non-governmental organisations), the Canadian Government is currently engaged in a national climate change process with sixteen Issue Tables of experts to examine and recommend options for meeting Canada's Kyoto commitments (see box).

By end of 1999, each of the Issue Tables had prepared a paper outlining options, or a series of options, to be considered for inclusion in a National Implementation Strategy. The benefits and costs of the options are being analysed, and will be presented to federal and provincial energy and environment ministers for consideration. Even with the formal report to joint ministers, expected in 2000, it will be some time until the National Implementation Strategy takes final form.

The Tables Process

Federal, provincial, territorial and municipal governments in Canada are working with interested parties to build a national strategy for achieving greenhouse gas emissions reductions. Beginning in July 1998, some 450 experts from a broad cross-section of government, business and industry, the academic community, environmental groups and non-governmental organisations have been participating in 16 Issue Tables/Groups that are examining and analysing the impacts, costs and benefits of options to address climate change.

The work of the Tables process is advisory only. The outcome of the process will form the basis of Canada's national implementation strategy for consideration by joint Ministers of Energy and the Environment (federal, provincial and territorial) over a series of meetings in 2000-2001.

The 16 Tables are:

- Agriculture and agri-food
- Analysis and modelling
- Buildings
- Credit for early action
- Electricity
- Enhanced voluntary action
- Forest sector
- Industry
- Kyoto mechanisms
- Municipalities
- Public education and outreach
- Science and adaptation
- Sinks (carbon sequestration)
- Technology
- Tradeable permits working group
- Transportation

PROJECTION OF EMISSIONS

In 1990, Canada's greenhouse gas emissions were 601 Mt of carbon dioxide equivalent. By 1997, the latest year for which data are available, they had risen to 682 Mt, a growth of 13%. The updated forecast suggests that by 2010, Canada's greenhouse gas emissions will increase to 764 Mt and by 2020 to 845 Mt. By 2010 greenhouse gas emissions would be some 27% above the 1990 level, and by 2020, in the absence of policy changes, they would be some 41% above the 1990 level (that is, 845 Mt as against 601 Mt). Projected carbon dioxide emissions have increased significantly since the previous outlook (1997). According to the latest projections, the Kyoto gap now amounts to 199 Mt carbon dioxide, compared with 138 Mt. Fossil fuel production (notably natural gas and oil sands) accounts for 60% of this increase, higher transport fuel demand 18%, increased electricity demand and lower nuclear production 14%.

Key assumptions for the projections are:

- Crude oil price US$ 20.60 per barrel 2000-2020 (1997 $).

- Natural gas price $US 1.95/Mcf in 2000 rising to US$ 2.10 in 2010 and stable to 2020 (1997 $).

- Economic growth 2.3% per year in the period 2000-2010 falling to 2.2% per year 2010-2020 and varying between provinces.

- Population growth from 31.2 million (2000) to 37.4 million (2020).

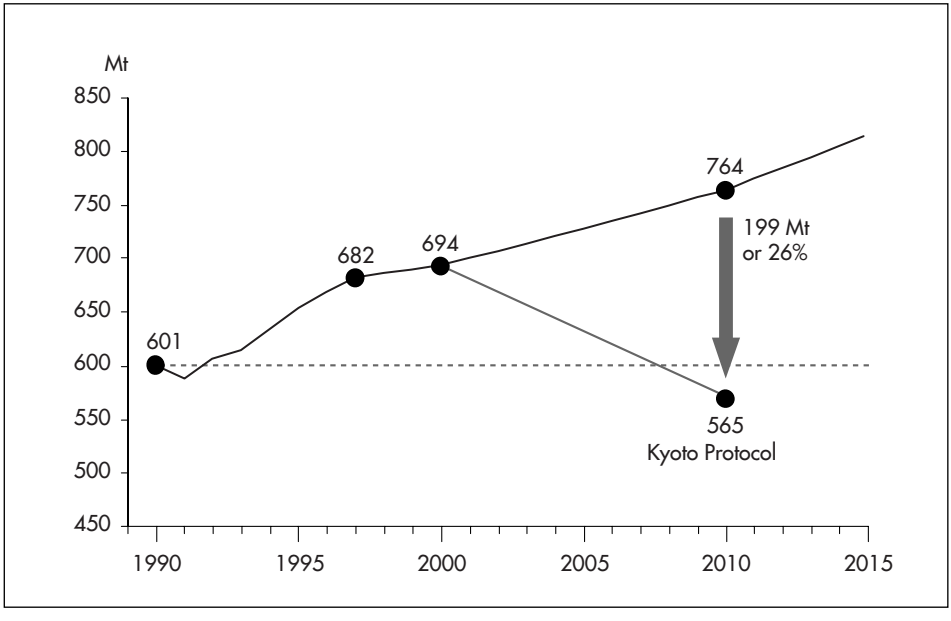
- The policy framework is assumed to be unchanged, but the effect of existing policies is taken into account.

- The share of nuclear and coal in electricity generation is expected to fall and the share of natural gas to rise.

- Energy intensity is expected to decline steadily: energy demand per unit of GDP is projected to decline at an average annual rate of 1.3% during the period 1997 to 2020.

Canada's Kyoto target for the 2008-2012 commitment period is 565 Mt of carbon dioxide equivalent each year. To achieve that target, emissions in 2010 must be reduced by 199 Mt. This represents a gap of some 26% between the projected level of emissions and the Kyoto target (see Figure 8).

Figure 8
Canada's Emissions Projection and Kyoto Target, 1990-2015



Source: Natural Resources Canada.

EFFECTIVENESS OF MEASURES

The projected level of emissions allows for the estimated impact of federal, provincial and municipal initiatives, including the Voluntary Challenge and Registry Program, that are the result of the National Action Program on Climate Change (NAPCC). Table 2 shows the effectiveness of policies implemented to date.

Table 2
Impact on Greenhouse Gas Emissions of Initiatives under the National Action Program on Climate Change
(Mt of CO_2 Equivalent)

	2000	*2010*	*2020*
Emissions Level Pre-Initiatives	728	824	945
Impact of initiatives			
• End-use	12	26	61
• Electricity generation	3	3	3
• Fossil fuel production	10	19	20
• Non-energy	10	12	13
Total impact of initiatives	**35**	**60**	**97**
Emissions Level Post-Initiatives	693	764	848
Initiatives as % of Pre-Initiative Level	4.8	7.3	10.3
Initiatives as % of Kyoto Gap	–	30.6	–

Source: Natural Resources Canada.

Overall, the NAPCC initiatives are estimated to reduce emissions by 35 Mt in 2000, 60 Mt in 2010, and by almost 100 Mt in 2020. Without these initiatives, emissions would be almost 8% higher in 2010 and 11% higher in 2020. Moreover, the Kyoto gap would have been about 30% larger. Over the longer term, the initiatives are expected to increasingly constrain emissions growth reflecting, in part, the working-through of improved standards and practices as energy-consuming capital stock turns over.

It is difficult to determine whether a particular action would have taken place in the absence of the Voluntary Challenge and Registry. Of the full impact of initiatives estimated for 2010, roughly 80% are expected to be the result of voluntary actions. A small proportion of the voluntary measures account for the bulk of the reduction. Many of the actions with significant impact by 2010, such as improvements in Dupont's adipic acid production process, and in oil and gas production, are voluntary actions.

TREND IN EMISSIONS

Table 3 shows long-term trends in greenhouse gas emissions by gas. By 2010, carbon dioxide emissions are expected to be 596 Mt, or 135 Mt (29%) higher than in 1990. By 2020, they are expected to be 201 Mt (44%) higher. Growth in carbon dioxide emissions is expected to account for slightly more than 80% of the increase in total emissions between 1990 and 2010.

Methane emissions are expected to follow the overall upward trend. The growth in nitrous oxide emissions is expected to decline after 1997 and remain below the 1997 level until after 2010. This pattern is the result of two offsetting developments. First, Dupont installed an emission control technology in 1997 at its Maitland, Ontario, adipic acid facility that will soon eliminate about 10 Mt (carbon dioxide equivalent) of nitrous oxide emissions. Second, and operating in the opposite direction, emissions of nitrous oxide from agriculture continue to increase over time.

Table 3
Greenhouse Gas Emissions by Gas
(Mt of CO_2 Equivalent)

	1990	*1997*	*2000*	*2010*	*2020*
Carbon Dioxide	461	520	537	596	662
Methane	75	90	90	92	97
Nitrous Oxide	57	64	57	62	65
Sulphur Hexafluoride	3	1	1	1	1
Perflurocarbons	6	6	6	6	6
Hydrofluorocarbons	0	1	2	7	14
Total	**601**	**682**	**693**	**764**	**845**

Source: Natural Resources Canada.

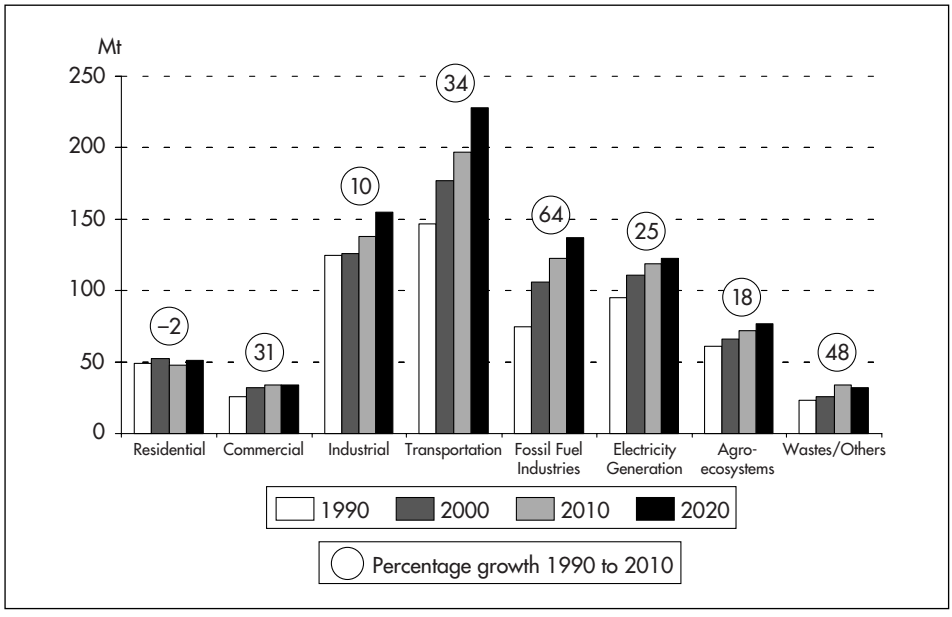
EMISSIONS BY SECTOR AND BY PROVINCE

The largest increases in emissions are forecast to occur as a result of the production of fossil fuels, followed by transportation.

Growth in emissions is in the larger provinces (Ontario and Québec) and in Alberta as a result of fossil fuel production. Provincial emissions reflect the differing fuel mix (notably the proportion of hydro available to the province) and the economic structure of each province.

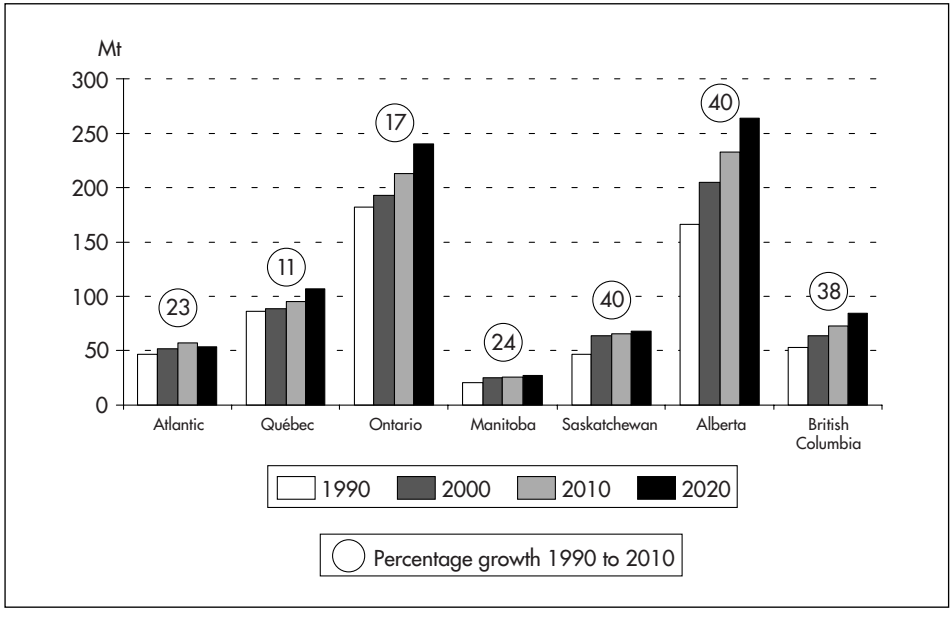
Compared with the national average of 22.5 tonnes of greenhouse gas emissions per person, provinces in order of emissions are Alberta (70.6 tonnes per person),

Figure 9
Greenhouse Gas Emissions by Sector, 1990-2020



Source: Natural Resources Canada.

Figure 10
Greenhouse Gas Emissions by Province, 1990-2020



Source: Natural Resources Canada.

Saskatchewan (58.5), New Brunswick (25.3), Nova Scotia (21.1), Ontario (17.2), Newfoundland (15.8), British Columbia (14.4), Québec (11.9), and Manitoba (11.6).

OTHER ENVIRONMENTAL MEASURES

Environment Canada, the federal government department, working with the Canadian Council of Ministers of the Environment and the National Air Issues Co-ordinating Mechanism, takes the federal lead in several other important areas where energy and environmental policies interface. These include:

- **Canada-Wide Standards for Ground-Level Ozone and Particulate Matter** are being developed under the Canada-wide Accord on Environmental Harmonization, which was established in 1998 by the Canadian Council of Ministers of the Environment. Under the Accord, national air quality objectives will be set and commitments made by the federal and provincial governments to achieve targets for emissions of particulate matter, NO_x and volatile organic compounds, through jurisdictional implementation plans.

- **The Phase 3 Federal Smog Management Plan** is a follow-up to the NO_x/Volatile Organic Compounds Management Plan, established in 1990 and the Phase 2 Federal Smog Management Plan published in 1997. Federal departmental sponsors of the Federal Smog Management Plans include Environment Canada, Agriculture and Agri-food Canada, Transport Canada and Natural Resources Canada.

- **The Canada and United States Air Quality Agreement** was signed in 1991 and commits Canada and the United States to address transboundary air pollution. Work under the Agreement has focused primarily on reducing emissions of the two major acid rain pollutants, SO_2 and NO_x. In 1997, the two countries signed the programme to develop a Joint Plan of Action for Addressing Transboundary Air Pollution, with the focus on ground-level ozone and particulate matter.

- **The Long-Range Transboundary Air Pollution Convention** was signed by 33 countries and the European Community in 1979 under the auspices of the United Nations Economic Commission for Europe. Protocols on persistent organic pollutants and heavy metals were signed in June 1998. Canada has signed and ratified these protocols and has signed but not ratified the protocol for volatile organic compounds (1991).

- **The Protocol to Abate Acidification, Eutrophication and Ground-Level Ozone** is the eighth and probably final protocol under the Long-Range Transboundary Air Pollution Convention. Canada and the US are participating in the negotiations. The protocol targets emissions of ammonia, nitrogen oxides (NO_x), sulphur dioxide (SO_2), and volatile organic compounds. The Canada/US Annex to the protocol will identify specific obligations with respect to SO_2, NO_x, and volatile organic compounds, which are the primary precursor air pollutants for acidification and ground-level ozone.

Harmonisation has been a priority for the federal, provincial and territorial Environment Ministers since the early 1990s, but is challenged by the diversity of provincial interests. Thus, in January 1998, environment ministers from across Canada, except Québec, signed the *Canada-Wide Accord on Environmental Harmonization* as well as three sub-agreements on inspections, environmental assessment and environmental standards.

Progress has also been made through bilateral discussions, for example on procedures for environmental assessment. To date, the federal government has signed bilateral agreements with the provinces of British Columbia (in April 1997) and Alberta (in June 1999). Bilateral agreements with the provinces of Saskatchewan and Manitoba were released for public consultation in July 1999, and efforts to develop agreements with the Province of Ontario and others are continuing. For those provinces or territories where there are no bilateral agreements, the environmental assessment of individual projects takes place through joint federal-provincial reviews, which are established through Memoranda of Understanding.

CRITIQUE

The key issues facing Canada in energy-environment policy are:

- Establishing a workable set of policies and measures from the Tables process, of sufficient strength to achieve the Kyoto target within the commitment period at acceptable economic cost.

- Settling a means by which the cost of meeting the Kyoto target is shared fairly among federal, provincial, territorial and municipal governments.

As environmental considerations of energy use have become prominent, the availability of abundant, relatively low-cost and carbon-based energy resources has created a dilemma for Canada. There are potentially high economic costs involved in complying with the national greenhouse gas emissions target, depending on the time frame for compliance and the nature of the instruments used. Canada has opted for voluntary measures (supported by market incentives), designed and implemented by stakeholders, to achieve a "no regrets" outcome. In the build-up to the implementation window for the Kyoto Protocol, it will be important for federal, provincial and territorial governments, industry, and stakeholders to demonstrate the effectiveness of measures preferred by Canada. These measures have not yet been defined.

The scale of the task imposed by Kyoto is very great and may call for stronger measures.

Initiatives taken to date have had a significant impact on the level of emissions projected for 2010 and 2020. However, the projections reveal a gap of some 26%,

which will need to be closed by additional means. Voluntary action is unlikely to be sufficient to close the gap. The Voluntary Challenge & Registry Inc. notes that "real action to reduce greenhouse gas emissions is crucial during the interim while our nation struggles to develop an abatement strategy" and that voluntary emissions reductions tend to be good investments that can benefit companies "from savings in energy costs and marketing leading edge technologies related to greenhouse gas reduction". However, the registry also notes that "We will continue to rely on federal, provincial and territorial governments to act as the key agent of change within their respective areas of activity. We depend on them to assist us in recruiting broad participation from all sectors of the economy, in deepening climate change commitments and in building momentum for the voluntary approach". Governments can achieve change where the market has failed to provide sufficient incentive because of, for example, inadequate information. However, beyond this level, efficiency improvements and structural change of the magnitude necessary to achieve the Kyoto target may require consideration of economic instruments to bring about sustained change in economic activity.

Table 4 shows the factors contributing to emissions increases in Canada, historically and forecast. Assuming policy actions commence in 2000, achieving the Kyoto target requires a reduction in greenhouse gas emissions of 2% annually. Government policies are unlikely to alter GDP per capita or population growth in pursuit of the climate change objective. Therefore, for Canada to achieve the Kyoto target by domestic actions alone would require a reduction in the carbon intensity of the economy of 4.3% annually. This is by historical standards a large reduction, exceeding the reduction achieved in Canada during the oil crises of the 1970s. The projected rate of decline, based on present policies, is 1.5% per year in the period 1997 to 2010, and 1.3% in the period 1997 to 2020. The rate of reduction required will call for a combination of significant energy or process intensity improvements, fuel switching, and use of flexibility mechanisms on a major scale.

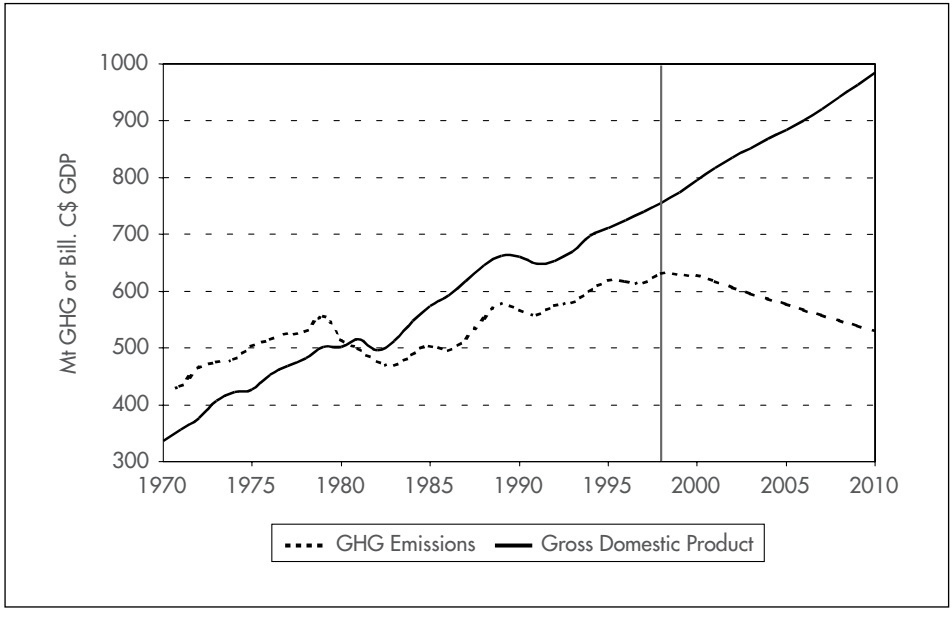
Table 4
Factors Contributing to Emissions Increases
(Average Annual Change)

	$\%\Delta GHG = \%\Delta GHG/GDP + \%\Delta GHG/POP + \%\Delta POP$			
1970 – 1980	2.1	–2.0	2.7	1.4
1980 – 1990	0.9	–1.8	1.5	1.2
1990 – 2000	1.4	–0.9	1.1	1.2
2000 – 2010	0.9	–1.4	1.4	0.9
Reduction to achieve Kyoto target: 2000 – 2010	–2.0	–4.3	1.4	0.9

%△ percentage change
GHG greenhouse gas emissions
GDP gross domestic product
POP population
Source: Natural Resources Canada.

The need for stronger measures is also demonstrated by the close relationship between economic growth and emissions in Canada. The historic and forecast trends in economic growth and emissions is illustrated in Figure 11. Sustained change of the magnitude required implies permanent structural change in the economy. The assumption behind the forecasts illustrated is for economic growth of some 2.4% per year in the period 1997 to 2020, which may be regarded as modest compared with the rates of growth achieved in recent years (for example, 3.7% in 1997).

Figure 11
Growth in Greenhouse Gas Emissions and GDP, 1970-2010



Source: Natural Resources Canada.

Co-operation with the provinces is essential.

Achieving commitment at all levels of government, and with other stakeholders, to the fair allocation of responsibilities for achieving the target will be crucial to the success of Canada's approach. Under the Canadian constitution, federal and provincial governments share jurisdiction over the environment. No single order of government has sufficient jurisdiction to effectively address complex environmental issues alone. There is an on-going need for the federal and provincial governments to co-ordinate their activities to best achieve concrete environmental results, to avoid gaps in environmental protection, to increase effectiveness and minimise unpredictability and inefficiencies in the environmental management regime.

Canada has experience through past federal-provincial efforts (for example, on reducing pollution of the Great Lakes, acid rain and emissions contributing to ozone

depletion) that co-ordinated action by governments on environmental issues of national importance produces more effective results than can individual jurisdictions acting alone. Since the 1970s, Canadian governments have used a co-operative forum, the Canadian Council of the Ministers of the Environment, to facilitate co-ordination of their environmental efforts. In the case of climate issues, the Joint Ministers of Energy and the Environment will be responsible for reviewing a strategy developed out of the Tables process.

A policy framework needs to be developed as part of the Tables process.

The forecasts prepared by Natural Resources Canada are an important step in preparing a framework for the discussions to follow the Tables process. They illustrate graphically the scale of the challenge and the limitations of current measures. The analysis should be taken further by defining the scope for the different categories of measures that might be agreed.

The Tables process is a "bottom-up" process that should produce useful and practical proposals, supported by many of the parties. The approach is clearly a move in the right direction to address a national issue in a federal system of government. It will be a challenge to produce a coherent set of measures through the process in the short time available. This would be helped if the parties could agree now to prioritise possible measures, at least in the first instance, on national cost-effectiveness grounds, and agree on the scale of contribution considered achievable for the key groups of measures.

The federal government could initiate discussion of this approach by undertaking a broad analysis building on the work of the Analysis and Modelling Group (one of the Tables) to develop a coherent package of measures to achieve Canada's greenhouse emissions target. This would assist a fast-track analysis of the individual components brought forward by the Tables. In particular, the federal government should actively seek to develop an integrated implementation strategy with the provinces, based on an overall analysis of the task. It should encourage industry to identify projects to be implemented under the Kyoto flexibility mechanism, and indicatively quantify the potential contribution of these in achieving the Canadian target.

Once agreed, mechanisms will need to be put in place to monitor progress, to respond to failure to comply with agreed measures, and to make corrections where measures prove to be insufficiently effective.

Some provinces will inevitably be more affected than others.

The provinces vary considerably in greenhouse gas emissions. Equitable sharing of the burden of meeting Canada's Kyoto target will be difficult and important. If cost-effectiveness is used as the criterion for selecting measures to reduce emissions, the overall cost to the nation will be minimised, even if the burden appears to fall more on some provinces than on others. This need not involve radical or sudden change if the instruments used allow the market to adjust to restrictions on carbon output. These might include, for example, a domestic system of emissions trading.

RECOMMENDATIONS

The Government of Canada should:

- ☐ Consistent with current policy, ensure that possible greenhouse gas emissions response measures are prioritised according to cost-effectiveness for the nation as a whole.

- ☐ Build on the work of the Analysis and Modelling Group (which is being conducted as part of the Tables process) to develop a coherent package of measures to achieve Canada's greenhouse gas emissions target, and move quickly to reaching agreement at all levels of government on a firm package of measures.

- ☐ Monitor progress towards achieving the share of Canada's greenhouse gas emissions target attributed to individual measures.

- ☐ Consider the economic implications of these measures on a regional basis in order to define regional efforts on a fair economic basis. A nation-wide emissions trading system could help equalise marginal costs and should alleviate regional differences.

- ☐ Encourage industry to develop projects using the Kyoto flexibility mechanisms, and indicatively quantify the potential contribution of these in achieving the Canadian greenhouse gas emissions target.

5

ENERGY EFFICIENCY

BASIC FEATURES OF END-USE POLICY

Since the early 1990s, Canada has widened the range of policy measures to foster a more efficient use of energy. Key objectives are to limit the environmental impact of energy use, and raise energy productivity to improve economic competitiveness. In recent years, concern about climate change has been the main driver for policy action. This strategy is currently under reconsideration in the context of the National Climate Change Process (see Chapter 4). It is likely that energy efficiency policy measures will be broadened and strengthened as a result of this process.

In its end-use policy, the federal government relies on a mix of mechanisms in order to overcome barriers to more efficient energy use. These include improving information and awareness of energy efficient products and practices, leadership by example, suasion, regulation, research and development and, to a minor extent, fiscal incentives. The Canadian and US economies are closely linked and Canada's policies need to take into account the effect they may have on competitiveness. Consideration also has to be given to the wide variation in end-use policies among the provinces. Energy efficiency policies need to be harmonised between provinces and take into account developments in the US.

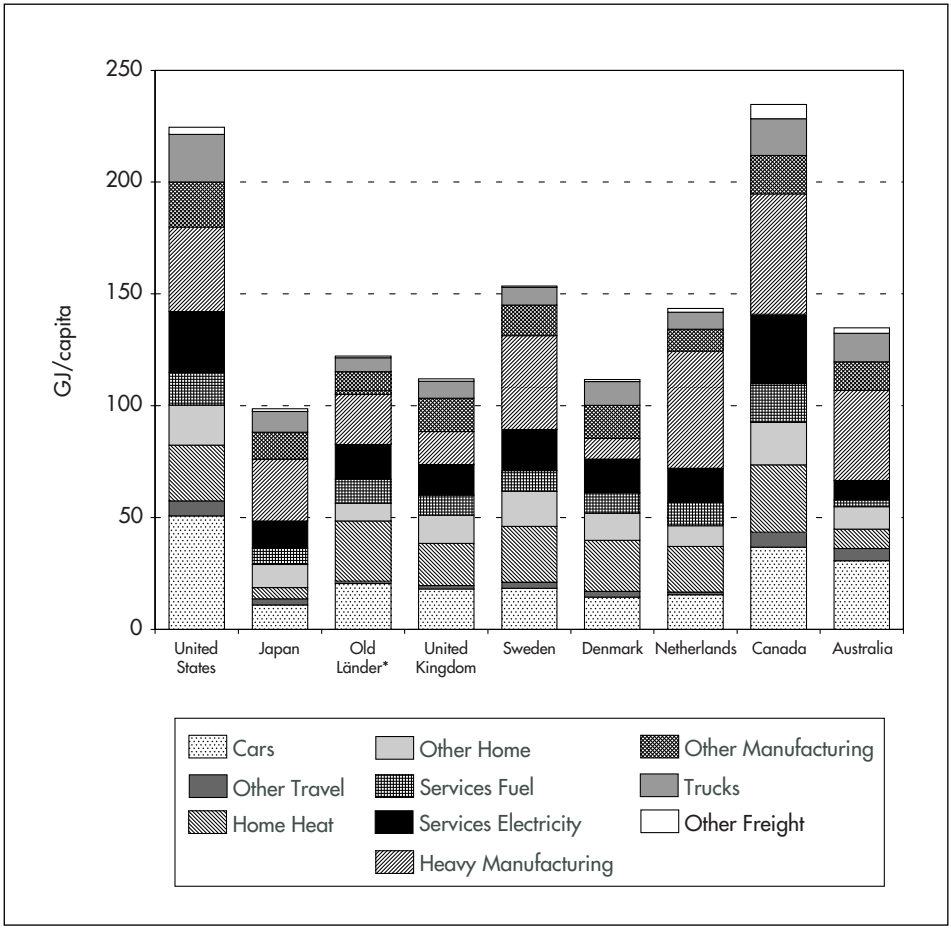
These features are reflected in the Energy Efficiency Act passed in 1993. The federal government has authority over:

- Regulation of energy performance levels of energy-using products (including windows and doors) that are imported or shipped between provinces.
- Energy labelling of these products.
- Collection of statistics and information on energy use and alternative energy.

The federal Energy Efficiency and Alternative Energy (EAE) Program started in 1991 and now comprises more than 30 initiatives in all end-use sectors. Figure 12 shows the trends in the EAE budget and its breakdown by purpose. The 1998-99 budget was increased to C$ 75.6 million. Over the past years, EAE expenditure has stayed relatively stable and even expanded. It should be noted that 50%-60% of EAE expenditure is dedicated to supporting research and development[6]. The recent increases in EAE expenditure in 1998-99 result from the start of several three-year programmes: the Commercial Building Incentive Program, Energy Innovators Plus and the Renewable Energy Deployment Initiative. A large share of the budgets for these programmes is used as investment incentives.

6 Part of the EAE research and development expenditure comes from the Program on Energy Research and Development (see Chapter 8).

Figure 12
Energy Use per Capita by Major End Use, 1994



* 1993.
Source: IEA, Energy Use in Canada in an International Perspective.

In addition to the increase in budget in 1998, the management of the market transformation component of the EAE Program was restructured to increase the visibility, transparency and accountability of the programme. The Office of Energy Efficiency (OEE) now manages the programme[7], other than research and development. Its effectiveness is measured through performance or "progress" indicators that try to evaluate programme output (products), programme outcome (effects on the target group) and market outcomes (market-wide effects) for each initiative. OEE's approach, including the use of progress indicators, was first documented in OEE's report to Parliament *Improving Energy Use in Canada* (1998).

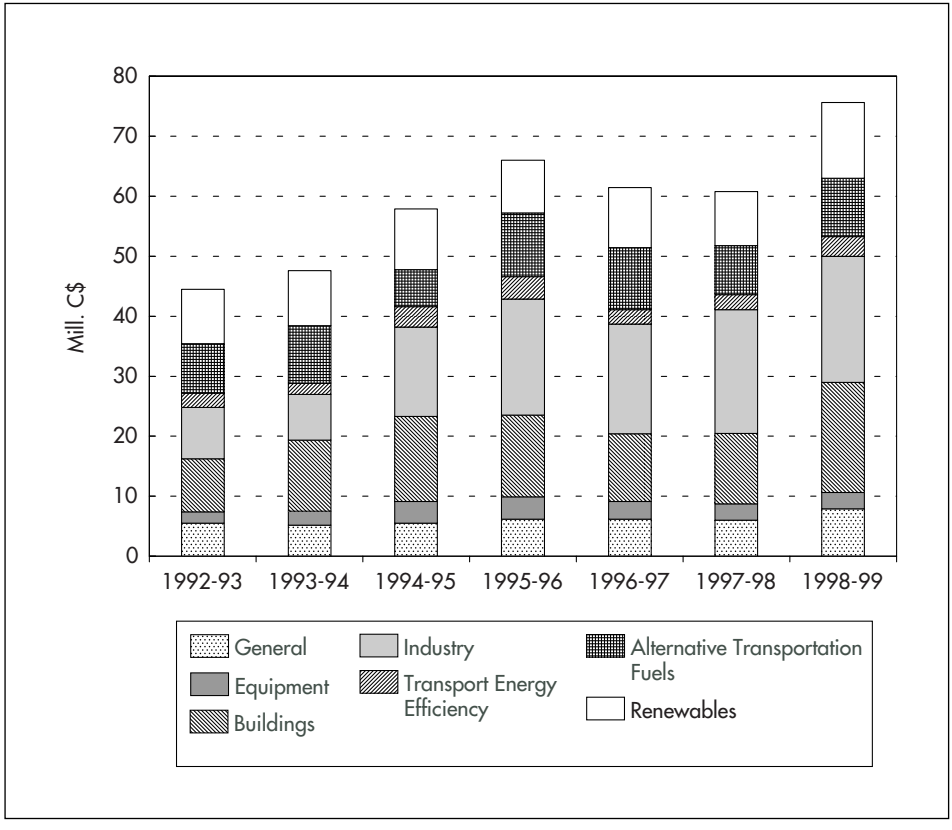
7 www.oee.nrcan.gc.ca

The federal government has limited jurisdiction over energy matters and provincial policy measures have an important role. Provincial end-use policies, including collaboration with federal programmes, vary significantly across provinces. Generally, provincial governments focus on energy supply issues and, apart from energy efficiency regulation of products, they appear to use and promote end-use initiatives – including those developed by the federal government – only to a limited extent.

End-use Energy Consumption and Trends

Aggregate Canadian energy intensity (as measured in final energy per unit of GDP or per capita) is among the highest in the OECD countries. This is partly due to climate, geography and sectoral structure. The differences between selected countries are shown in Figure 12. Final energy consumption rose in Canada between 1990 and 1997 by 11.4% to 7 791 PJ.

Figure 13
Government Expenditure in the Energy Efficiency and Alternative Energy Program



Source: Natural Resources Canada.

Table 5

Factors Influencing Growth in Secondary Energy Use, 1990-1997 (petajoules)

	Energy Use			*Activity Effect*	*Structure Effect*	*Weather Effect*	*Energy Efficiency Effect*	*Interaction Effect*	*Other*
	1990	*1997*	*1997 less 1990*[5]						
Residential	1 307	1 385	79	175.4	9.8	53.4	–140.1	–19.9	..
Commercial[1]	895	1 015	120	118.8	2.0	16.9	–16.4	–0.1	–1.4
Industrial	2 741	3 068	327	345.9	155.2	..	–129.1	–44.7	..
Transportation	1 850	2 093	243	304.7	108.1	..	–149.8	–22.0	2.2
Passenger[2]	1 160	1 240	79	155.5	4.9	..	–61.8	–9.1	–10.2
Freight	637	788	151	149.2	103.2	..	–88.0	–12.9	0.0
Off-Road Motor Gasoline[3]	53	65	12	..	..	..	..	..	12.4
Agriculture[4]	199	230	31	..	..	..	..	..	30.9
Total	**6 992**	**7 791**	**800**	**945.0**	**275.0**	**70.0**	**–435.38**	**–86.63**	**31.69**

.. not available.

1 The factorisation excludes street lighting. The change in energy use for this component from 1990 to 1997 is shown in the "Other" column.

2 The factorisation excludes the non-airline (commercial/institutional and public administration) air sector and motorcycles. The difference in energy use for the non-airline and motorcycles component is shown in the "Other" column.

3 The factorisation analysis is for off-road motor gasoline. The change in energy use for this component from 1990 to 1997 is shown in the "Other" column.

4 The factorisation analysis was not undertaken for the agriculture sector. The change in energy use for this component from 1990 to 1997 is shown in the "Other" column.

5 The change in energy use between 1990 and 1997 shown in this column and the sum of the activity, structure, weather, energy efficiency and interaction effects for passenger and freight transport are slightly different because of the exclusion from the factorisation analysis of the non-airline and motorcycle segments in passenger transport. The sector differences are reflected at the secondary energy use level; other differences excluded from the factorisation such as agriculture, off-road motor gasoline and street lighting are included under "Other".

Note: Sectoral energy consumption has been revised and is therefore not compatible with data given in Table 6.

Source: *Energy Efficiency Trends in Canada, 1990-1997*, NRCan 2000.

Several features of Canada's energy use patterns contribute to the high level of aggregate energy intensity, which limit the relevance of this indicator for international comparison. Canada is the largest IEA Member country and has a climate, as measured in population-weighted degree days, that ranks with Finland as the coldest in the IEA. Cold climate combined with homes among the largest in the IEA results in a very high energy demand for space heating, which is partly offset by high insulation levels. The same is true for the commercial sector. In the manufacturing sector, Canada has a very high concentration of output in a few very energy-intensive industries (non-ferrous metals, pulp and paper, etc.) that boosts aggregate manufacturing energy use relative to total GDP in manufacturing. The large size, combined with a sectoral structure dominated by bulk goods (energy carriers, minerals, metals, pulp and paper etc.), gives Canada the highest domestic freight (measured in tonne-km) per unit of GDP. The high share of rail in freight transportation offsets some of the potential effect on the energy consumption.

In order to understand these country-specific features, and to gain insight into sectoral energy use and efficiency trends, the Canadian Government has developed a National Energy Use Database (NEUD). OEE regularly updates, analyses and publishes *Energy Efficiency Trends in Canada*, where disaggregated sectoral data are collected and indicators are calculated to monitor energy efficiency progress. An overview is given in Table 5. Despite the challenges of reliable data collection and interpretation, and the difficulty of judging the effectiveness of different policy measures using these indicators, the database provides insights for monitoring of trends and priority setting in the end-use area.

SECTORAL TRENDS AND POLICY INITIATIVES

Residential and Commercial Sector

In 1997, the shares of residential and commercial energy consumption in end-use were 18% and 13% respectively. Residential and commercial energy consumption rose by 6% and 13.4% respectively between 1990 and 1997. The energy intensity improvement between 1990 and 1997 was higher in the residential than in the commercial sector with –1.5% per year and –0.26% per year respectively. The demand outlook (NRCan 1998) expected that the energy intensity would improve substantially (by –1.6% per year and –1.2% per year until 2010) as a result of the numerous policy measures developed and employed in the meantime, but also as an effect of population and economic growth to 2010 that should favour stock turnover. These expected intensity improvements have been revised downwards in the latest update, since the uptake of some measures, in particular the model-building code, appears to be slower than expected.

Regulation and labelling of household and commercial appliances and equipment are expected to lead to the elimination of less energy-efficient models of equipment from the market. To date, 30 products in the residential and commercial sectors are subject to energy efficiency regulation in Canada. In the residential sector, appliances and

products that account for 73% of the residential energy demand are covered. They included appliances and white goods, air conditioning equipment, water-heating equipment, furnaces and lighting equipment.

Federal regulations on imported products and products traded between provinces complement provincial regulations for intra-provincial markets, and generally parallels regulations in the US. In the past, these two features have influenced the scope and performance requirements of federal regulations. Recently, the federal government has started to examine the regulation of other products such as windows, and the strengthening of the performance levels of currently regulated products such as for refrigerators, freezers and washing machines.

The EnerGuide for Equipment labelling programme supplements the minimum performance requirements, and seeks to stimulate consumer awareness and to influence purchasing decisions. It covers household appliances and air conditioners. This labelling scheme is mandatory for new products and gives a comparative assessment of energy efficiency and energy consumption for a range of appliances on the market. The programme is supplemented by information, education and training campaigns that try to reach consumers through stakeholder alliances, or retail sales personnel. Market place audits revealed that over 80% of the regulated parties complied with the labelling requirement.

A number of programmes target residential and commercial buildings through different mechanisms. Most prominent are the Model National Energy Codes for new residential and commercial buildings, which may be adopted by the provinces as binding. The federal government supplements such efficiency standards through a number of information, suasion and marketing support measures. The R-2000 programme, for example, establishes a voluntary standard and a certification scheme for new houses that are up to 50% more efficient than homes built to the Model National Energy Code for Houses. R-2000 also targets home building companies through education and training schemes. Most provinces and territories participate in the R-2000 Home programme and two (Manitoba and Yukon) deliver the programme in their territory. Other provinces work with provincial home builder associations to encourage a higher rate of construction of energy-efficient housing. When provinces have given grants to investors to comply with these standards there has been a much higher adoption rate of the ambitious R-2000 standard in new buildings than might be expected on a purely voluntary basis.

In the existing building stock, the Reno$ense programme aims to promote efficient renovation practices through publicity and marketing support to producers of efficient products, training and certification of renovators and information to home owners.

EnerGuide for Houses is a labelling and certification programme, which gives guidance to owners on purchasing energy-efficient houses, and on the evaluation of houses before and after retrofitting. A voluntary Window Labelling Program (rating and labelling) similar to EnerGuide for Equipment is administered by an association of manufacturers. It applies to windows and doors. The HVAC Energy Efficiency

Rating Program is a voluntary initiative by manufacturers to use the EnerGuide methodology and labelling in the promotion of their products.

Several programmes aim at increasing efficiency in buildings in the commercial/institutional sector. In addition to the Model National Energy Codes, the Commercial Building Incentive Program gives financial incentives for new buildings that are at least 25% more efficient than the model standard. The Federal Buildings Initiative gives executive and managerial support to building managers and personnel of federal buildings. A similar effort for private entities is run in the Energy Innovators Initiative/EI Plus initiative, that provides tools and services for participants on innovative options for implementing and financing building retrofits (including performance contracting support). Participants can register their voluntary efforts under the Voluntary Challenge and Registry Program (VCR) scheme (see Chapter 4).

Industry

Industry, including mining and oil extraction[8], accounts for 39% of end-use energy consumption. The sector is dominated by six large energy-intensive sub-sectors (smelting and refining, chemicals, pulp and paper, iron and steel, mining, petroleum refining). These sub-sectors account for 79% of industrial energy consumption, but only for 27% of the industrial production value. Development of this highly energy-intensive industrial structure has been encouraged by Canada's very low energy prices compared with other OECD countries.

Between 1990 and 1997, industrial energy consumption increased by 11.9%. Disaggregated indicators have been developed to analyse the drivers to industrial energy consumption growth, using physical units (for example tonnes of product), where feasible. In this way, changes in industry structure and energy intensity, and trends in industrial energy consumption, can be reliably evaluated.

- 12.6 percentage points of the energy consumption increase stem from increased industrial production.

- 5.7 percentage points are due to shifts towards more energy-intensive branches and production.

- Improvements in energy intensity (energy per value of industrial production) compensated 4.7 percentage points (–0.7% p.a.).

If measured per unit of physical output instead of by value, the energy intensity changes vary strongly among the different sectors. On average, improvements over the six years were relatively modest, especially since 1993. In short, growth and

8 These sectors are usually categorised as transformation rather than industry, but are included for reasons of compatibility with Canadian indicator data.

shifts towards energy-intensive industries and products such as non-metal mining and pulp have far outweighed energy intensity changes.

Federal government initiatives rely on voluntary schemes to secure commitment of companies to energy savings efforts (such as the Industrial Energy Efficiency Initiative); specific science and technology programmes (audits, implementation support, research and development support for energy-efficient technologies) for certain sub-sectors and applications; and regulation, such as for electric motors and as proposed for distribution transformers.

The federal government involves industry in voluntary action to promote energy efficiency through two schemes. The Canadian Industry Program for Energy Conservation (CIPEC) is a long-standing voluntary industry mechanism that defines sector-specific targets for energy efficiency and develops action plans to achieve them. The government initiative, Industrial Energy Innovator, provides support services for investment in energy efficiency investments and practices to achieve sectoral targets provided company support for the target has been assured. The results from this voluntary scheme can be registered in the Voluntary Challenge and Registry Program (VCR, see Chapter 4).

Most industrial sectors have made commitments under CIPEC to improve energy intensity (measured in energy per physical output unit) for most sub-sectors by 1% per year, between 1995 and 2000. Exceptions among the energy-intensive sectors are cement, breweries and textiles that have committed to 0.7%, 3% and 2% respectively. Past energy intensity trends in these sectors show that historical improvements between 1990 and 1996 have usually exceeded these targets.

The federal government as well as the provincial governments support a number of science and technology initiatives on heat management, advanced combustion, process optimisation and control, mineral and metal technologies mostly through consortium-based development and demonstration, and various support tools for implementation. In industry, relatively few products are regulated, such as electric motors, which parallel regulations in the US. Distribution transformers are currently under consideration for regulation. The initiatives taken so far are considered to limit the expected growth in industrial fuel consumption by 97 PJ (13% of expected growth between 1990 and 2010).

Transport

Transportation accounts for 27% of final energy consumption, and increased its energy consumption by over 13% between 1990 and 1997 (passenger +6.8%, freight +23.8%). Canada has one of the highest levels of activity in passenger transport among the OECD countries (measured in passenger-kilometres per capita). Geography, high car ownership and comparatively low fuel prices (although slightly higher than in the US) contribute to this situation. High shares of cars and domestic aviation in the total passenger-kilometres travel contribute to the high energy use per

capita in passenger transportation. In parallel to the US Corporate Automobile Fuel Economy (CAFE) standards, Canada has a voluntary scheme which sets a minimum level for fuel economy (measured in miles per gallon) of cars and light trucks. Rapid improvements in new passenger vehicle efficiency during the 1980s have gradually resulted in on-road fleet improvements that have slowed since the mid-1990s (–62PJ between 1990 and 1997, equivalent to a fuel intensity improvement of –0.7% p.a. between 1990 and 1997). The increase in vehicle weight and power since the late 1980s, and the shift towards light trucks, is a structural shift that has increasingly reduced fuel performance of new passenger vehicles.

Freight activity (measured in tonne-kilometres hauled or production value) is high compared to other OECD countries and reflects the high share of bulk products from the basic materials industry and the large distances of the country. The sectoral structure is favourable since freight transport contains a high share of rail (suited best for bulk products over long distances), but the share of trucking is increasing. This structural shift has offset almost all fuel intensity improvements in freight, estimated at –1.9% per year between 1990 and 1997.

In the demand outlook, lower fuel intensity improvements than in the recent past are assumed for new passenger and freight vehicles. As a result, activity increases are likely to drive energy consumption, which is expected to grow at about 1% a year to 2020. Even with these rather optimistic assumptions on a decreasing fuel intensity (in absence of any further policy measures), transportation is expected to be the sector with the highest growth in energy demand.

Transportation fuels are taxed by the federal government and the provinces. The federal excise tax amounts to 10 cents per litre for gasoline, and 4 cents per litre for diesel. A federal goods and services tax adds 7% for gasoline and diesel[9]. Provincial taxes vary considerably between 6.2 and 16.5 cents per litre with little difference for diesel and gasoline. On average (across provinces), the fuel price is about 10% higher than in the US.

Apart from the voluntary fuel consumption targets agreed with manufacturers for cars and light trucks, the federal government relies on information and education initiatives to induce consumers and companies to fuel efficient purchasing decisions and vehicle use. For this purpose, different programmes aimed at different target groups have been devised. Auto$mart provides information for private motorists on buying, driving and maintaining their vehicles in a fuel-efficient way. Since 1999, the voluntary labelling scheme EnerGuide for Vehicles has provided standardised comparisons of fuel economy in new vehicles. For haulage operators and drivers, Fleet$mart supports energy-aware fleet management practices through energy efficiency guidelines, energy use profiles and benchmarking, case studies and driver training initiatives. Finally, the *FleetWise* programme is a government leadership initiative that targets federal vehicle fleets in order to improve their fuel efficiency through improved purchasing, utilisation and

9 In some provinces both taxes are replaced by a single harmonised sales tax of 15%.

Table 6

Overview of the End-Use Sector in Energy Demand and Carbon Dioxide Emissions
1990 Levels, Growth and Impact of Initiatives

	1990	*1995*	*1997*	*Expected increase in 2010 over 1995 (without policy initiatives taken)*[1]	*Expected impact of initiatives in 2010*[2]	*Expected impact by 2020*[2]
Energy (PJ)						
Residential	1 359	1 423	1 476	+163	–147	–240
Commercial	865	978	1 008	+273	–67	–89
Industry	3 015	3 327	3 428	+729	–97	–115
Transportation	2 099	2 247	2 402	+622	–77	–135
Total	**7 337**	**7 975**	**8 314**	**+1 787**	**–388**	**–579**
Direct end-use GHG emissions (Mt CO_2 equivalent)[3]						
Residential and agriculture	43	45	47			
Commercial	26	30	30	+41[4]	–21[5]	–53[5]
Industry	104	109	107			
Transportation	140	150	162	+55[4]	–5[5]	–8[5]
Total	**313**	**334**	**346**	**+96**[4]	**–26**[5]	**–61**[5]

1 Calculated from updated outlook on energy demand including recent policies impact, *Canada's Emissions Outlook: an update* (NRCan 1999), Table C-8 and the policy impact evaluation in the previous, *Canada's Energy Outlook 1996-2020* (NRCan 1997), Chapter 3. See also 2.

2 Only effects after 1995 are considered. These effects have been re-evaluated in the emissions outlook update (NRCan 1999), but are not quantified in PJ. Data from the old outlook (NRCan 1997) are therefore given. The inconsistencies should be minor.

3 CO_2 emissions for 1990, 1995, 1997 from *Canada's Emissions Outlook: an update* (NRCan 1999, Table C-24).

4 Increase over 1990.

5 Some of these evaluations were revised in the new outlook to an extent that is not easily quantified. The breakdown of the emissions reduction impact of policy initiatives in transportation and other end-use is therefore approximate.

Note: Energy consumption data are taken from Annex C of *Canada's Emissions Outlook* (NRCan 1999) are not compatible with similar data in *Energy Efficiency Trends in Canada – an update* (NRCan 2000).

Sources: *Canada's Energy Outlook 1996-2020*, and *Canada's Emissions Outlook: an update*.

maintenance practices. It also mandates a high share of alternative fuel use in these fleets. These initiatives are expected to reduce the expected growth until 2010 over 1990 (472 PJ or 31%) by 77 PJ or 16%.

Impact of the policy initiatives on emissions of carbon dioxide.

Fostering energy efficiency is one of the key elements of the Canadian approach on the limitation of carbon dioxide emissions. The contribution of energy efficiency was evaluated in the previous outlook for the period 1996 to 2020 (see Table 7). The residential sector is the only sector where the impact of policies taken since 1990 are considered to effectively limit carbon dioxide emissions by 2010, but on a level slightly above emissions in 1990. Equally important, the measures become increasingly effective even after 2010 because of the slow stock turnover in buildings. In all other sectors the balance is less positive, since activity increases and structural changes are expected to outweigh the energy intensity improvements triggered by the policy initiatives. In addition, the current measures will have yielded most of their impact by 2010.

CRITIQUE

Efficiency policy is in transition as climate measures are developed.

The concern over further and rapidly increasing carbon dioxide emissions has given rise to the creation of the National Climate Change Process that is expected to result in concrete recommendations to enhance current climate policy measures, including in the end-use area. The considerations below are based on the policies in place. The existing policy is in transition and major changes may result in the near future.

Efficiency has gained in priority and important measures are in place.

The creation of the Office of Energy Efficiency has increased the transparency and accountability of Canada's energy efficiency programme. The National Energy Use Database and the reports *Energy Efficiency Trends in Canada* provide a good analytical basis for understanding energy use and efficiency trends in Canada. Both the database and the work on energy efficiency trends are valuable for priority setting and monitoring sectoral policy initiatives in the end-use sectors. They could be used to establish targets for efficiency programmes, in terms of intensity improvements, and energy or carbon dioxide emissions saved. In contrast to funding for other areas of energy policy, the Efficiency and Alternative Energy Program has resisted pressure for budget cuts and even increased its budget in recent years.

Comprehensive regulation and labelling of appliances and equipment are in place in the residential and, to a lesser extent, in the commercial sector. Standards, codes

and regulations cover a large share of household energy consumption and achieve – where they are of a mandatory nature – a high penetration in the market. The assessment of their effectiveness in the 1997 outlook clearly shows its positive impact on energy consumption and carbon dioxide emissions despite significant growth in population and income. In the commercial sector, the effect is less marked. In this sector, and also in the medium term in the residential sector, a widening and strengthening of the building codes in the provinces appears possible. The adoption of, for example, the Model National Energy Code for Houses and Buildings or the participation in the R-2000 Program varies widely in the provinces. In the new outlook, the impact of the model building code across Canada has been re-evaluated downwards since widespread adoption is less advanced than expected previously. For appliances, federal Canadian regulation is influenced by initiatives in the US. For the coming years, the challenge remains for the federal government to foster a widespread adoption of regulation and codes by the provinces, in order to achieve the expected limitation of carbon dioxide emissions. New, innovative collaborative schemes with the provinces to foster implementation "on the ground" might be needed for this purpose. Especially for appliances and equipment, the task for the federal government will be to gain an accepted and proactive role in the tightening of standards, taking into account standards in the provinces and in the US.

There is a focus on voluntary measures for industry and the agreed rate of improvement does not appear to be a significant step beyond autonomous energy intensity improvements.

The federal government's approach in industry relies on voluntary measures, and information and training material in support of energy-efficient practices. An exception is the efficiency regulation on electric motors. This focus, coupled with extremely low energy prices, tends to support the conclusion that there is little economic incentive to industry to further minimise energy consumption. The voluntary approach dates back to the 1970s and government-industry collaboration has reached a remarkably high coverage of the national industrial players, as documented now in the Voluntary Challenge and Registry programme. But the commitments under these agreements may not be sufficient to meet the present-day challenge of energy conservation and carbon dioxide emissions mitigation. At least in some sectors, the detailed energy efficiency use and indicator work seems to suggest that these commitments reflect a rate of improvement close to the level of autonomous change. A commitment beyond this level is likely to be necessary. With the detailed information of past intensity changes in industry now available, and the voluntary mechanisms well in place, the government should strive to encourage stronger commitments, if the overall doctrine of voluntary action is to be maintained.

The pace of change is limited by US policy.

In transportation, federal measures rely mostly on the potential to establish improved practices and behaviour, through labelling, training and other information

measures. With Canadian markets closely intertwined with the US, the range for domestic manoeuvre is perhaps most limited in this sector and explains the focus of the current policy programmes. Yet, it is one of the sectors with the expected highest increases in energy consumption and carbon dioxide emissions.

In the longer term, structural change will be necessary.

In industry and transportation in particular, the detailed analysis of energy use and efficiency trends reveal a dilemma for policy in many countries: structural changes, such as the shift to larger vehicles or energy-intensive products, are understood to considerably increase energy consumption, despite modest energy intensity improvements for each vehicle and product class. This is not surprising in an environment of low energy prices and high economic growth, since there is little economic incentive through market forces towards efficiency and structural change which would lead to an overall less energy-intensive economy. In the longer run, both sides of the equation – efficiency and structure – need to be mobilised and stimulated. With a strong reliance on voluntary and information measures, only marginal efficiency improvement actions tend to be mobilised. In other words, the integration of sectoral programmes in a broader economic approach could greatly enhance the effectiveness of the otherwise well developed sectoral programmes. A broader economic approach is difficult on a unilateral basis in strongly linked economies such as Canada and the US (a situation similar to Europe, and other close trading partners). On the other hand, leaving economic incentives, and thus structural change, out of the equation is likely to limit the scope for change and reduce the effectiveness of existing programmes. Measures such as differentiation of vehicle taxation according to fuel efficiency, or selected fiscal incentives, might be worth considering in this context. This category of measures and their consistent integration with the existing approach clearly have to involve federal and provincial government action.

New measures and stronger integration of policies are necessary.

New measures to improve energy efficiency are likely to emerge from the Tables process. A further strengthening of the current energy efficiency programme is likely to be called for. The development of indicative emissions reduction objectives and targets for end-use measures could be an initial step that would then allow a further strengthening, tailoring and prioritisation of programme measures. In the end-use area, the integration of the existing programmes with further market-based measures (the recent commercial buildings incentive programme is an example) is necessary to maximise their impact. Where competitive disadvantages for industry are expected, the potential for more stringent voluntary commitments in place of fiscal and regulatory requirements could be negotiated. The uptake of the existing, well-developed programmes could be enhanced greatly by introducing additional market-based measures.

RECOMMENDATIONS

The Government of Canada should:

- ☐ Consider establishing clear objectives, possibly as quantified targets, for the contribution of end-use policies and programmes to reducing greenhouse gas emissions.

- ☐ Strengthen commitments made under voluntary agreements with industry.

- ☐ Develop closer relations between federal and provincial energy efficiency programmes, and assist provinces wishing to develop energy efficiency policies and programmes.

- ☐ Consider supplementing and integrating current sectoral programmes with economic incentives in order to maximise the uptake of efficient practices.

6

ELECTRICITY, NUCLEAR AND RENEWABLES

ELECTRICITY

Industry Structure

Electricity is primarily within the jurisdiction of the provinces and Canada's electricity industry is organised along provincial lines. Electricity generation and transportation within a province fall under provincial jurisdiction. Interprovincial and international electricity trade and facilities fall under federal jurisdiction[10]. In most provinces, the industry is highly integrated with the bulk of generation, transmission and distribution provided by a few dominant utilities. Although some of these are privately-owned, most are Crown corporations[11] owned by the provincial governments.

The following is a brief overview of the current structure of the industry in each province and restructuring plans. Typically, provinces historically established a single government organisation – such as a commission or board – to be responsible for generation, transmission and distribution of electricity. In most cases, the organisation was incorporated at a later date, but generally with the provincial government as the sole shareholder. Incorporation generally involved narrowing the activities of the corporation to electricity and relinquishing other operations such as gas supply. In some cases, relatively small generators also exist, but not in direct competition with the dominant Crown corporation. Municipally-owned distributors are common.

Alberta

There are three major electricity utilities in Alberta: TransAlta Utilities Corporation (generating 63% of electricity in the province in 1996), Alberta Power Limited (16% of generation) and Edmonton Power (17% of generation). TransAlta and Alberta Power are investor-owned. A transmission network owned by TransAlta links all three utilities. The three utilities supply about 98% of electricity in Alberta. The

10 "… the powers of the Parliament of Canada, extensive though they may be on matters of trade, are quite limited insofar as electricity matters generally are concerned. The constitution assigns to the provinces exclusive jurisdiction over electricity matters that are wholly intra-provincial in nature, and it assigns to the provinces concurrent powers with respect to interprovincial trade. Furthermore, it is the ability of the provincial utilities to enter into purchase and sales agreements, combined with the electricity supply policies of the provincial governments, that primarily determine both the nature and the extent of Canadian electricity trade. The Canadian government, if it is to achieve policy objectives related to electricity, can therefore achieve very little by acting unilaterally. First and foremost, it must seek provincial consensus and provincial cooperation." *Electric Power in Canada 1997*, Canadian Electricity Association and Natural Resources Canada (1999).

11 Crown corporations are established under legislation as "agents of the Crown", i.e., the government.

remaining 2% are generated by industry. Over 80% of electricity generation in Alberta is coal-fired.

Since 1 January 1996, all electricity, whether generated in Alberta or imported, has been sold into a power pool. The distributors (Edmonton Power, TransAlta, Alberta Power and the cities of Calgary, Lethbridge and Red Deer) and exporters purchase electricity according to a market price set each hour. TransAlta announced in January 2000 its intention to sell its Alberta retail and distribution businesses.

In 2000, it is proposed to auction the right to sell the output of each generating unit owned by the utilities. The successful marketers will then bid into the pool as at present. Each generating unit will have a long-term power supply agreement with the marketer. The policy was developed as a means of increasing the number of participants in the pool, without obliging the utilities to divest their generating assets.

The Alberta Electric Utilities Act, 1995 established open transmission access, a competitive power pool, and an independent Transmission Administrator responsible for planning and financial management of the transmission system. The Alberta Electric Utilities Amendment Act, 1998 introduced retail competition.

Principal features of the reformed electricity market in Alberta are:

- The high-voltage transmission system and local distribution continue to be regulated monopolies, but other components of the market have been deregulated to introduce competition.

- All customers will be able to choose between competing electrical retailers by 2001. Residential and farm customers will be able to choose a stable rate option from their existing supplier for five years; small businesses will have a stable rate option for three years.

- A power pool will continue to be the wholesale market for electricity bought and sold in Alberta, governed by the independent Power Pool Council. The council monitors markets, investigates complaints and resolves disputes.

- A Transmission Administrator, regulated by the Alberta Energy and Utilities Board, will oversee the use of the transmission system to ensure fair system access rates and non-discriminatory access, and the safe and reliable operation of the transmission system.

- In 2001, long-term (20-year) Power Purchase Arrangements will replace the current mechanism for recovering the costs and benefits of existing generation, to ensure that generators recover their forecasted costs for existing facilities for the period 2001-2020.

- Marketers may purchase, via an auction process, the right to bid the output of a generating unit into the power pool, as a means of introducing more participants to the pool without breaking up the existing generation companies.

TransAlta Utilities was the first Canadian utility to successfully apply for a Federal Energy Regulatory Commission marketers' licence in the United States and has moved quickly to establish its presence in the US market. TransAlta is now ranked as the thirteenth largest power marketer in the US.

Ontario

Ontario Power Generation Inc. (OPG), which has assumed all of the generation assets of the former Ontario Hydro, is a provincially-owned corporation that generates electricity in Ontario. Ontario Hydro Services Company (OHSC) is a separate company that has assumed the extensive transmission and distribution assets of the former Ontario Hydro. OHSC transmits wholesale electric power to 257 municipal utilities that in turn retail it to customers in their service areas. In total, OHSC and the municipalities serve about four million customers. About 108 large industrial customers are supplied directly with power and OHSC distributes power to more than 962 000 small business and residential customers in rural and remote areas. OPG operates 82 power stations: 69 hydroelectric, 6 conventional thermal and 5 nuclear.

There are also a number of small regional utilities in Ontario, such as the Great Lakes Power Limited, a private hydroelectric generation and distribution company serving about 11 000 customers directly and another 30 000 indirectly.

In October 1998, the Energy Competition Act was passed to restructure Ontario Hydro and to introduce competition in the province's electricity market by establishing:

- Retail and wholesale competition before the end of 2000.
- An Independent Electricity Market Operator, a new non-profit independent corporation with operational control over the provincial transmission system, to despatch generation and manage a power exchange.
- Generation business open to power producers which meet the province's environmental standards and which receive a licence to generate electricity.
- Ontario Power Generation Inc. (OPG), incorporated under the Business Corporation Act with the province holding all of the shares. OPG owns and operates all of the generation assets of the former Ontario Hydro.
- Ontario Hydro Services Company (OHSC), incorporated under the Business Corporation Act with the province holding all of the shares. OHSC has assumed all of the transmission and distribution assets of the former Ontario Hydro.
- Open access on the provincial transmission grid and local distribution networks.

In January 1999, the Ontario Market Design Committee submitted its final report on market design and rules for review by the Ontario Minister of Energy, Science and

Technology. Under the Energy Competition Act, the Ontario minister has the authority to approve the first set of rules under which a reformed electricity market will operate. The rules will then be officially transferred to the Independent Market Operator. The Ontario Energy Board will be the body of appeal for future amendments to the rules.

The wholesale market consists of a voluntary pool and bilateral contracting. To enhance competition, the province has adopted rules that will end OPG's near monopoly of the power market. When the electricity market opens in 2000, the utility will have a 90% share of domestic generation capacity, but it is required to reduce this to 35% over the next 10 years. To date, Bruce nuclear plant, Lakeview coal-fired plant (Mississauga) and Lennox dual-fired natural gas and oil plant (near Kingston) have been offered for sale by OPG. These plants account for about 7 000 MW out of a total capacity of about 31 000 MW. Within 42 months, OPG must reduce its control of the price-setting (that is, marginal) plants to 35%. During the transition period, an average annual cap of 3.8 cents per kilowatt-hour will apply to 90% of OPG's estimated domestic energy sales. If the market price is higher, the difference between the capped price and the market price will be rebated to customers, while other generators will receive the market price.

British Columbia

British Columbia Hydro was established as a Crown corporation to provide electrical services throughout the province, except for portions of the southern interior which are served by West Kootenay Power Limited. British Columbia Hydro is the third largest electric utility in Canada, generating, transmitting and distributing electricity to 1.5 million customers or over 90% of the population of the province. West Kootenay Power Limited is a US-owned utility generating and distributing hydro-electricity to over 80 000 customers. It also supplies seven distributors which serve about 40 000 customers.

In 1988, British Columbia's mainland gas operations and its rail operations were privatised. Several utilities were created including British Columbia Power Export Corporation (POWEREX), which was established to trade in electricity with US utilities.

In 1995, the British Columbia Utilities Commission recommended an incremental approach to reforming the electricity market in the province. The transmission and generation businesses of British Columbia Hydro (a Crown corporation) were separated on an accounting basis in 1995 and open access to British Columbia Hydro's wholesale transmission system was allowed in 1996.

In 1997, the provincial government established a Stakeholder Task Force, but was unable to reach consensus on retail access reforms being sought by industrial customers. However, also in 1997, BC POWEREX received US FERC Power Marketing Authorisation that enables the company to compete in the US electricity market.

In January 1998, a report submitted to the provincial government recommended that industrial customers be able to choose a power supplier for up to 50% of requirements by early 1999 and 100% by 2001. In 1998, British Columbia introduced legislation to provide rebates on 1997/98 power bills and to freeze rates for all BC Hydro customers for two years.

Québec

Hydro-Québec is a Crown corporation responsible for the generation, transmission and distribution of most of the electricity sold in Québec to about 3.4 million customers. It also trades in electricity with neighbouring provinces and the US. Hydro-Québec has a 34.2% interest in Churchill Falls (Labrador) Corporation Limited, which owns and operates the Churchill Falls power plant. In 1996, Hydro-Québec had a total of 78 generating stations (49 hydroelectric, 28 thermal and one nuclear), and was one of the largest electric utilities in North America.

The Québec wholesale market has been open since 1 May 1997. In the same year, Hydro-Québec obtained a US FERC Power Marketing Authorisation. The wholesale market comprises 11 distributors: Hydro-Québec, nine distributors operating municipal systems and one regional electricity co-operative. All distributors can now purchase electricity outside Québec, and an independent producer in Québec can sell outside Québec. However, no sales to Québec have occurred, apart from Hydro-Québec's direct purchases from outside Québec.

TransÉnergie, a division of Hydro-Québec, operates the transmission system in Québec.

The act respecting the Régie de l'énergie states that the government may, when it deems appropriate, ask the Régie de l'énergie to look into the possibility of opening up the retail market. Hydro-Québec considers that there would be no tangible benefits to consumers from retail competition. Accordingly, it does not expect any initiatives on this matter in the short term and does not intend to promote opening of the market.

Manitoba

Manitoba Hydro is a Crown corporation, which produces almost all the province's electric power. It also distributes electricity throughout the province, except for the central portion of Winnipeg, which is served by the municipally-owned Winnipeg Hydro. Manitoba Hydro serves more than 390 000 customers and Winnipeg Hydro over 100 000 customers. Manitoba Hydro produces electricity from 12 hydroelectric generating stations, 2 thermal stations and 12 diesel sites.

In 1996, Manitoba Hydro became a full member of the Mid-Continent Area Power Pool. Subsequently, in 1997, the Manitoba Hydro Amendment Act allowed wholesalers of electricity open access to Manitoba Hydro transmission facilities. The act prohibits retail competition.

New Brunswick

The New Brunswick Electric Power Commission (a Crown corporation) owns and operates 15 generating stations (including one nuclear) and also purchases electricity from Québec. New Brunswick Power serves 300 000 customers directly and a further 40 000 customers through sales to two municipal utilities.

In 1997, the government of New Brunswick announced support for deregulation and competition. An open access tariff for certain transactions using New Brunswick Power's transmission system was announced in January 1998. At present, the province's independent power producers can use New Brunswick's transmission system to wheel-out their production, but non-discriminatory conditions have not been established to allow external suppliers to wheel-through energy to customers outside New Brunswick. In February 1998, the government issued a paper for public discussion of electricity industry restructuring: *Electricity in New Brunswick Beyond 2000*.

Other Provinces

Until 1992, Nova Scotia Power Inc. was a provincial Crown corporation producing and distributing electricity throughout the province. In 1992, the corporation was privatised. About 80% of output is generated from coal, at the Lingan station on Cape Breton Island.

Newfoundland and Labrador Hydro Corporation (NLHC) is the principal generator of electricity in Newfoundland. Newfoundland Power is the principal distributor, purchasing most of its power from NLHC and generating the balance (about 10%) from its own small hydro facilities. In total, about 250 000 customers are served by the two utilities. Newfoundland Power is a subsidiary of FORTIS Inc, which also owns the Maritime Electric Company Limited on Prince Edward Island. NLHC is the parent company of a number of subsidiaries, including the Churchill Falls (Labrador) Corporation, which owns and operates the Churchill Falls plant. The Churchill Falls plant is one of the largest power facilities in the world and supplies Québec on very favourable terms (see under Québec above).

In March 1998, Newfoundland and Québec announced the beginning of formal negotiations between Newfoundland and Labrador Hydro Corporation and Hydro-Québec, with a view to reaching agreement for the completion of the hydroelectric development of the Churchill River in Labrador and other related projects in Québec. The memorandum of understanding currently being negotiated proposes the building of a new generating station on the lower Churchill River (2 264 MW at Gull Island), with possibly another 824 MW as Muskrat Falls and a new 1 000 MW facility at the existing Churchill Falls site. The proposal includes a new transmission line through Québec and an "in-feed" transmission line under the Strait of Belle to connect to the principal area of population around St Johns. There has been no decision on financing of the in-feed. General in-principle agreement has been reached that electricity could be transmitted across adjoining provinces to allow wider marketing of electricity from projects such as proposed for the lower Churchill River.

The Saskatchewan Power Corporation is a Crown corporation generating, transmitting and distributing electricity in the province for about 420 000 customers. In 1996, coal-fired stations produced about 68% of total electricity production, hydro 26% and gas 5%. In 1989, SaskEnergy became a separate company responsible for the gas operations of the corporation.

Maritime Electric Company Limited operates a fully integrated generation, transmission and distribution system on Prince Edward Island, based on two oil-fired generating plants. Two submarine cables link the system with New Brunswick's power grid.

Fuel Use in Electricity Generation

Fuel use in electricity generation is illustrated in Figure 14. Hydro is the dominant fuel used, followed by coal, nuclear, gas and oil. Gas is expected to be the fuel showing the fastest growth and may replace other forms of generation as gas combined cycle plants increase in number. Preliminary data for 1998 indicate a rise in the percentage share of coal (from 17.4% in 1997 to 20% in 1998), gas (from 4.1% to 5%) and oil (from 2% to 3%) since 1997, in part replacing a fall in nuclear (from 14.4% to 13%), and a fall in the share of hydro (from 61.1% to 59%).

Electricity Consumption

Growth in electricity consumption is illustrated in Figure 15. Canada is the third largest consumer of electricity per capita, after Norway and Iceland.

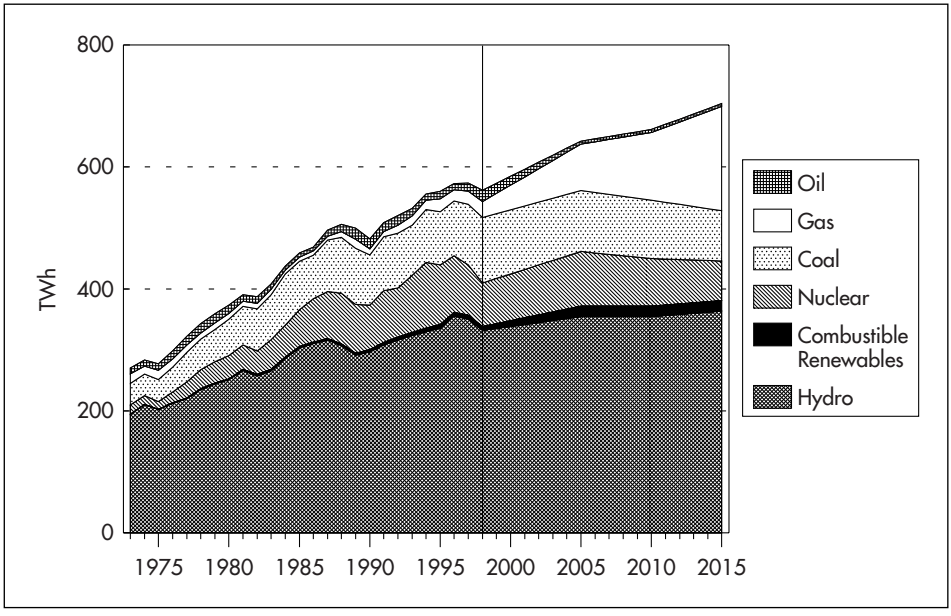
Electricity Prices

The IEA does not have recent data on electricity prices in Canada. The Government of Canada believes prices are low on an international comparison in the residential, commercial and industrial sectors.

Regulation

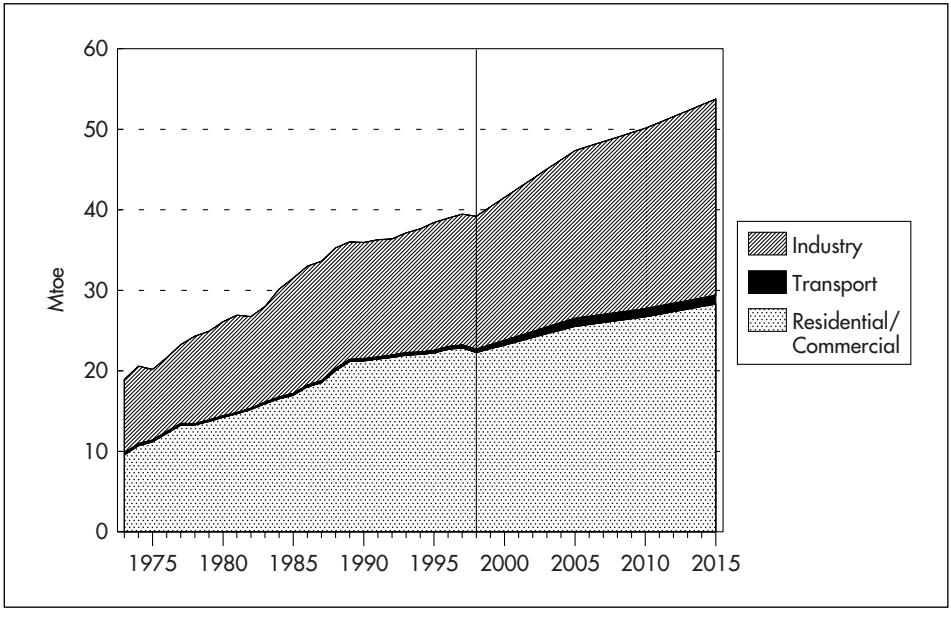
The powers of the federal government are limited in relation to electricity, except in relation to nuclear energy where it has exclusive jurisdiction. The constitution assigns to the provinces exclusive jurisdiction over electricity matters that are wholly intra-provincial in nature, and it assigns to the provinces concurrent (that is, with the federal government) power with respect to interprovincial trade. Since the provinces can enter into purchase and sales agreements, provincial policies can determine the nature and extent of trade in electricity. Any initiative by the federal government can only be successful if supported by the provinces. General competition law does not apply to the electricity or gas sectors, except where no provincial law applies.

Figure 14
Electricity Generation by Fuel, 1973-2015



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1999, and country submission.

Figure 15
Electricity Consumption by Sector, 1973-2015



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1999, and country submission.

The National Energy Board

The National Energy Board advises the federal government on the development and use of energy resources, and regulates specific matters concerning oil, gas and electricity. The board's jurisdiction over electricity matters is limited to the certification of international and designated interprovincial power lines and the licensing of electricity exports from Canada. The board has no jurisdiction over imports of electricity.

In relation to international power lines, the board is required to consider the effect of the power line on other provinces and the impact of construction and operation of the power line on the environment. Although interprovincial electricity trade is under federal jurisdiction, the National Energy Board Act does not provide for regulation of interprovincial electricity sales. The board has no authority where power from one province simply enters the grid of another province, but may regulate a designated interprovincial power line in the same manner as an international power line.

Provincial Regulation

Provinces, with the exception of Saskatchewan, New Brunswick and Québec, have some form of independent (that is, independent of government and the industry) regulatory bodies to oversee the utilities, but the degree of supervision varies. The major areas subject to review are rate setting and the construction of new facilities.

In Saskatchewan, the legislature is the regulatory body while in New Brunswick rates and operations are regulated by a Board of Commissioners which includes among its members the chairman and vice-chairman of New Brunswick Power.

In Québec, since December 1996, the Régie de l'énergie (Québec Energy Board) has provided a regulatory framework for energy distribution. The provincial government has the option of pointing out the economic, social and environmental effects that it would like the board to consider. Although electricity rates are subject to the board's approval, a rate freeze is in place until 2002 and the policy of Hydro-Québec is to maintain rate stability through cross-subsidisation between residential customers and smaller industrial customers. Hydro-Québec's transmission and distribution activities are subject to regulation based on the cost of service for those activities. For power generation, the government of Québec dictates the initial conditions for establishing supply rates, which represent the energy portion of the customer's bill. The board conducted public hearings on the implementation of a commodity tariff for electricity, and a report was submitted to the Québec government in August 1998.

Trade in Electricity

Most provinces have agreed to provide cross-provincial transmission access in accordance with the Agreement on Internal Trade.

Figure 16
Electricity Trade, 1997
(GWh)

Source: *Electric Power in Canada 1997* (Canadian Electricity Association and Natural Resources Canada, 1999).

Trade with the US

Canada is the second largest electricity exporter in the OECD after France. Electricity trade with the US is encouraged by several factors. Price differences make export to the US profitable and attractive to US buyers; electricity supply systems in the US and Canada can have different seasonal peaks which make trade in surpluses possible. Electrical systems in Canada can experience their peak demand in winter, while most electrical systems in the US have their peak in summer[12]. Canadian hydraulic sources are also attractive on environmental grounds to replace fossil sources.

Since 1921, Canada has been a net exporter of electricity to the US. Electricity exports are an important component of Canada's foreign trade. Net exports grew substantially from the early 1970s and reached a peak of 45 TWh in 1987, reflecting rising costs of thermal production in the US. Interruptible exports account for more than half of all exports. Exports currently account for about 8% of production but less than 2% of total US electricity demand. The proportion of demand met by Canadian exports in some regions of the US can be considerably higher, for example around 13% in New England and 6% in New York.

Interprovincial Trade

Since 1975, interprovincial trade in electricity has been consistently higher than international trade. Interprovincial trade is dominated by the Churchill Falls power project owned by Newfoundland and Labrador Hydro (with a minority interest held by Hydro-Québec). Production commenced in 1972. Over 65% of all interprovincial trade is accounted for by this single project. Under the power contract, about 90% of the Churchill Falls production is sold to Québec on very favourable terms. Hydro-Québec buys 5 429 MW at an average 0.3 cents/kWh.

Although there are significant geographical limits to interprovincial trade, there nonetheless appear opportunities to expand interprovincial trade. The National Energy Board's Review of Inter-Utility Trade in Electricity (1994) concluded that major benefits would arise from expanding trade, principally from trade with the US, but also from interprovincial trade.

Policies Affecting Trade

In April 1999, the US Federal Government introduced comprehensive electricity restructuring legislation that provides, among other things, a provision for mandatory standards for reliability for US electric transmission and generating systems, replacing the current voluntary, industry-developed, reliability standards.

12 In 1999, Ontario's peak demand was experienced in July and the all-time summer peak can be equal to the all-time winter peak. This is a function of growing air conditioning load and switching of space heating to natural gas.

The bill provides for an industry-based self-regulating organisation to develop, monitor, and enforce the standards, with oversight by the Federal Energy Regulatory Commission. It is envisaged that the self-regulating organisation would be an international organisation, carrying out similar functions in Canada and Mexico.

Federal and provincial energy ministers have established a working group to advise ministers on inter-jurisdictional issues concerning the implementation of mandatory reliability standards in Canada that would be compatible with a North American-wide mandatory reliability system.

Canada's National Energy Board Act was amended in 1990 to streamline significantly export authorisations. Electricity producers and marketers may now apply for these authorisations for up to 30 years. The National Energy Board may issue export authorisations without a public hearing process if there are no major "public interest" issues that require a public hearing. The main criteria for export authorisations are extra-provincial impacts, environmental impacts, and avoidance of price discrimination against potential Canadian electricity purchasers. Over the longer term, as electricity markets are opened and there is greater integration of North American markets, the Canadian Government considers that there may be a need to review export regulation and the role of the National Energy Board with respect to electricity.

In October 1998, federal and provincial energy ministers approved a legal text for the Energy Chapter. The Energy Chapter of the Agreement on Internal Trade provides for non-discriminatory, open transmission access across the provincial jurisdictions and dispute resolution procedures. Energy ministers passed the text of the chapter to trade ministers to conclude, subject to the resolution of outstanding issues that were outside the mandate of energy ministers. Until the broad regional benefits and investment issues are resolved by trade ministers, the Energy Chapter cannot form part of the Agreement on Internal Trade. Direction was sought from the Committee on Internal Trade in late 1999, but no outcome has been announced.

NUCLEAR

Canada's nuclear industry consists of predominantly public sector organisations involved in all areas of the nuclear fuel cycle, including the mining and milling of uranium, fuel fabrication, power reactor construction and operation, and waste disposal and decommissioning of nuclear facilities.

The Government of Canada has played a key role in the development of the nuclear industry by funding nuclear research and development, and by establishing the institutional and regulatory framework for health and safety, and protection of the environment in all fuel cycle activities. The nuclear industry is based on the unique

CANDU heavy water reactor system (CANada Deuterium Uranium). CANDU reactors, unlike light water reactors, use natural uranium as fuel.

Two organisations play key roles in the Canadian nuclear energy programme. Both report through the Minister of Natural Resources Canada to the Parliament of Canada:

- **Atomic Energy of Canada Limited (AECL)** is a Crown corporation wholly owned by the Government of Canada. AECL develops, markets, sells and builds the CANDU power reactors, MAPLE research reactors and MACSTOR Waste Storage Facilities.

- **The Atomic Energy Control Board (AECB)** is the federal nuclear regulator on health, safety, security and environmental protection. In 1997, Parliament passed the Nuclear Safety and Control Act in replacement of the Atomic Energy Control Act of 1946, which established the AECB. The new act is expected to come into force during 2000 after the necessary regulations are finalised.

Natural Resources Canada develops and implements nuclear energy policy and provides information and advice on the supporting institutional, legislative and financial frameworks for the nuclear industry in Canada.

Electricity Production

Nuclear energy is an important component of Canada's energy mix. Twenty-two CANDU reactors, owned and operated by utilities in Ontario (20 reactors), Québec (one reactor) and New Brunswick (one reactor), provide on average about 15% of Canada's electricity.

Table 7
CANDU Reactors in Operation

Reactor	*Province*	*MWe*	*In Service Date*
Pickering A	Ontario	4 × 515	1971-73
Bruce A	Ontario	4 × 769	1977-79
Point Lepreau	New Brunswick	1 × 635	1983
Pickering B	Ontario	4 × 516	1983-86
Gentilly-2*	Québec	1 × 638	1983
Bruce B	Ontario	4 × 860	1984-87
Darlington	Ontario	4 × 881	1990-93

* Gentilly-1 was shut down in 1979.
Source: Natural Resources Canada.

The following table shows the role of nuclear in Canada's electricity supply.

Table 8
Nuclear Power in Electricity Generation
(As at 31 December 1999)

	Canada	*Ontario*	*New Brunswick*	*Québec*
Nuclear Share (%) of Electric Utility Generation	13.4	43.8	21.1	2.8
Reactors in Service	14	12	1	1
Capacity in Service (Net MWe)	10 301	9 028	635	638

Note: As of 31 December 1999. Bruce A 1, 2, 3 and 4 were taken out of service indefinitely in October 1997, October 1995, April 1998, and March 1998 respectively. Pickering A 1, 2, 3 and 4 were taken out of service indefinitely at the end of 1997.
Source: Natural Resources Canada.

Future Role of Nuclear Power

Following declining performance, the Board of Directors of Ontario Power Generation Inc. announced a Nuclear Asset Optimisation Program in August 1997. Eight of OPG's 20 operating CANDU reactors were taken out of service and attention was focused on the 12 newer units at Bruce B, Pickering B and Darlington in order to bring the units back to their previous standard of performance. Restart of the reactors will depend, in part, on other generation options available to the utility.

Because of the requirement for significant investment before the Bruce A units could be brought back into service, it is likely that the Bruce A (1, 2, 3 and 4) reactors will only recommence operation if they are sold to new owners. The Bruce A 2 reactor requires extensive refurbishment and may be shut down permanently although no formal decision has been taken to decommission the reactor. The anticipated increased competition from low-cost hydro-based and fossil-based generators resulting from a move to a competitive electricity market could seriously affect the economic decision as to whether or not to bring back into service some or all of the nuclear units.

The New Brunswick government is also reviewing the future structure of the electricity market and the future role of New Brunswick Power. Recent studies by New Brunswick Power have shown that the Point Lepreau reactor could not be expected to be operated beyond 2008 without substantial new investment. The decision New Brunswick Power and the government must take regarding investing to extend the life of Point Lepreau beyond 2008 will involve a comparison between the total costs of electricity production at Point Lepreau and the total cost at an alternative facility.

The Gentilly-2 nuclear generating station at Bécancour, Québec represents 2% of Québec's total installed capacity. Hydro-Québec will have to determine whether to retube Gentilly-2, expected to be required in 2008. Hydro-Québec will have to take

into account the cost of the alternative methods of generating electricity available at that time. The government of Québec is not considering the privatisation of the electricity market within the province.

Prospects for the future are limited to the replacement of existing reactors as they retire. The main priority for the domestic nuclear industry is expected to return existing CANDU units to a high level of operating performance. The laid-up Pickering reactors are expected to be returned to service over the next few years, but there is some doubt about the future of the laid-up Bruce units unless they are sold. Nuclear power plants retiring before 2020 may attract investment to extend their operating lives, or they may be replaced by fossil-fired electricity generation capacity.

Climate Change

Total emissions of carbon dioxide from the Canadian electric power sector are on average about 100 Mt per year, or about 17% of Canada's total emissions. For the period 1971 to 1996, cumulative avoided emissions of greenhouse gases from the use of nuclear energy in Canada are about 1 222 Mt or about 50 Mt per year. Nuclear power has also avoided other emissions from the power sector, such as emissions of nitrogen, sulphur and volatile organic compounds.

The short-term impact of the closure of the Pickering and Bruce units is estimated by the Government of Canada to have increased greenhouse gas emissions by about 18 Mt over the period 1998-2000. The return of the Pickering A units to service would reduce annual greenhouse gas emissions by 15 Mt.

Waste Management

Nuclear fuel waste from existing CANDU reactors is currently stored at the reactor sites. Research has been conducted by Atomic Energy of Canada Limited (AECL) into a concept of deep geological disposal of nuclear fuel waste in the stable rock of the Canadian Shield. An environmental assessment and review panel, established under the Federal Environmental Assessment and Review Process Guidelines, completed a comprehensive public review of the AECL disposal concept and issued its report to the federal government in March 1998.

On 3 December 1998, the Government of Canada released its response to the panel report. The panel reached the conclusion that: "From a technical perspective, safety of the AECL (deep geological) concept has been on balance adequately demonstrated for a conceptual stage of development, but from a social perspective, it has not". The government expects that the producers and owners of nuclear fuel waste will establish and fund a waste management organisation, incorporated as a separate legal

entity, with a mandate to manage and co-ordinate the full range of activities relating to the long-term management, including disposal, of nuclear fuel waste.

The Government of Canada considers that a federal oversight mechanism is needed to ensure that appropriate long-term solutions to nuclear fuel waste management are developed, funded, and implemented. The key objectives of a proposed oversight mechanism would be to ensure that:

- A dedicated fund is established for nuclear fuel waste management, including disposal;
- A reporting relationship is established between the federal government and the waste management organisation; and that
- A federal review and approval mechanism is established to provide oversight and access to the fund.

The response made clear that the federal government is looking at options, including legislation, to ensure that the three fundamental policy objectives are met. Natural Resources Canada is consulting with a wide range of stakeholders, including the public, to determine if there are other options that would be as effective as legislation.

The Minister of Natural Resources is to recommend to Cabinet his preferred options for implementing federal oversight over broader aspects of the long-term management, including disposal, of nuclear fuel waste, in addition to existing health and safety requirements of the federal government.

Safety

A new Nuclear Safety and Control Act will come into force in 2000 to update Canada's regulatory system after the regulations under the act have been approved. The act enhances the independence and powers of the regulator.

International

Nine CANDU reactors are currently in operation or under construction outside of Canada. CANDU reactors constitute 10% of the world market in nuclear power.

Uranium

Uranium mining has been undertaken since the 1930s. Canada is the world's leading producer of uranium, accounting for roughly one-third of global production since 1985. Canada has vast high-grade deposits of uranium and is expected to remain the leading producer in the world. Producing areas are illustrated in Figure 17. Production began in the east, but the main producing areas are now in the Northwest Territories.

Table 9
CANDU Reactors in Operation or under Construction

Reactor	*Country*	*MWe*	*Year in Service*
Wolsong 1	Korea	1 × 629	1983
Wolsong 2	Korea	1 × 629	1997
Wolsong 3	Korea	1 × 629	1998
Wolsong 4	Korea	1 × 629	1999
Embalse	Argentina	1 × 600	1984
Qinshan 1 and 2	China	2 × 700	2003
Cernavoda 1	Romania	1 × 629	1996
Cernavoda 2	Romania	1 × 629	Uncertain

Source: Natural Resources Canada.

Resources

Canada is the largest producer of uranium in the world. Canada produced double the output of uranium of the second largest producer, Australia, in 1996. Estimated Canadian reserves represent about 20% of total OECD reserves.

Canada's known uranium resources as of 1 January 1999, recoverable at a cost of US$ 80/kgU or less, are estimated to be about 433 000 tonnes (of uranium in the ore). Uranium resources recoverable at a cost of US$ 40/kgU or less are estimated to about 372 000 tonnes. The bulk of Canada's known uranium resources are in Saskatchewan and in the Northwest Territories. The average grade varies from less than 1% uranium to over 10% uranium.

Production

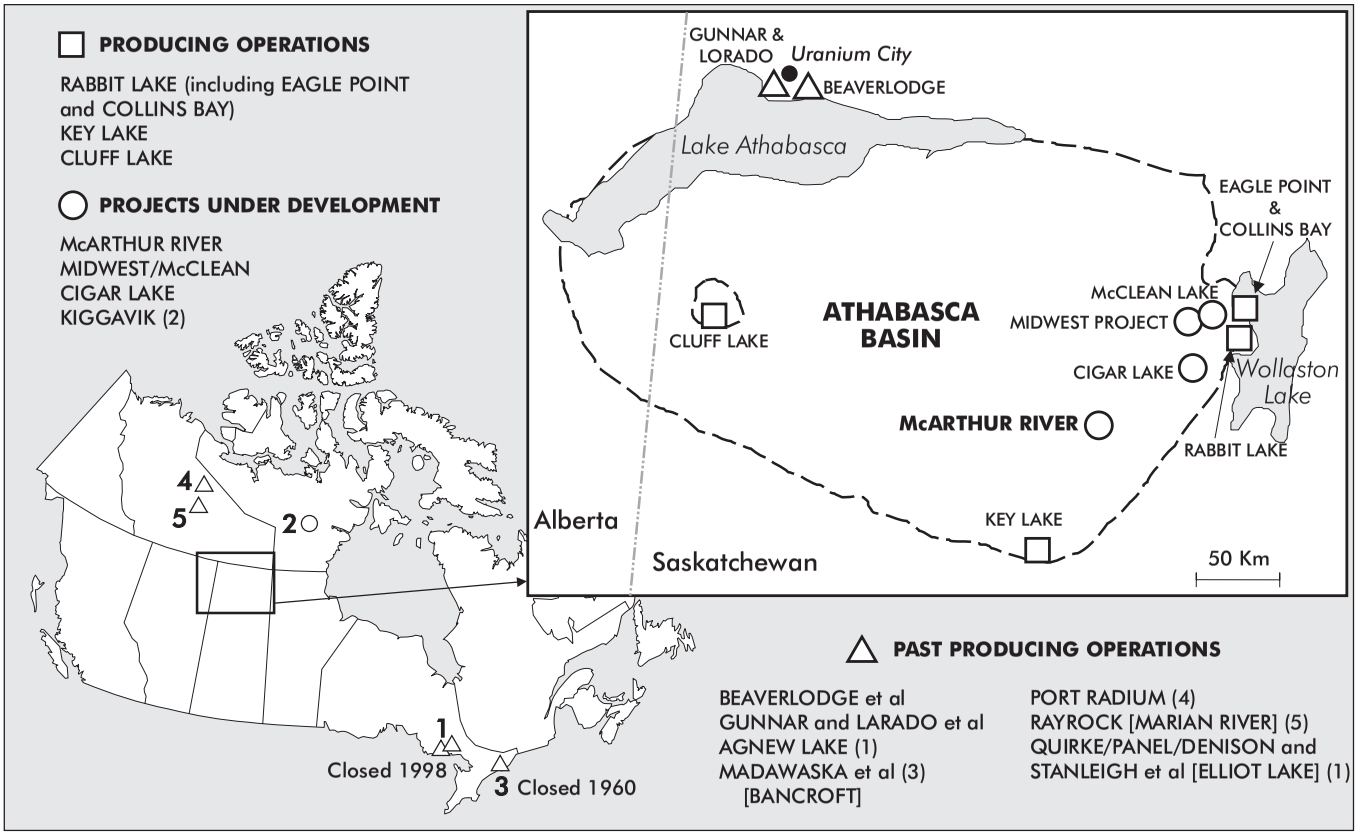
Annual output grew steadily throughout the 1980s, as Canada's focus of uranium production shifted increasingly from east to west. In the early 1990s, low prices led to the closure of three of four Ontario production centres. The last remaining Ontario uranium production centre closed in mid-1996.

Table 10
Uranium Production

	Pre-1996	*1996*	*1997*	*1998*	*Total to 1998*	*Expected to 1999*
Mining method (tonnes of uranium contained in ore)						
Conventional mining						
• Open pit	..	6 528*	9 266*	7 637*	..	
• Underground	..	5 178*	2 765*	3 285*	..	
Total	**286 967****	**11 706****	**12 031**	**10 922**	**321 626**	**330 126**

.. not available.
* Estimated split between open-pit and underground.
** Primary output.
Source: OECD Nuclear Energy Agency.

Figure 17
Uranium Mining in Canada



Source: Natural Resources Canada.

Canadian uranium output remains below full capability. Producers in Canada announced production cutbacks in 1999 in response to the low uranium market price and to ease the transition to new high-grade uranium mines that are poised to enter into production. As a result, Canada's production, which in 1997 exceeded 12 000 tonnes, declined to 10 922 tonnes in 1998 and fell to about 9 000 tonnes in 1999.

Structure of the Uranium Industry

In April 1998, the corporate structure of uranium mining in Canada was significantly altered when Cameco Corp. announced that it had entered into an agreement in principle to purchase Uranerz Exploration and Mining Limited and Uranerz USA Inc. from their parent company, Uranerzbergbau GmbH (UEB) of Germany. The acquisition strengthened Cameco's position as the world's largest uranium producer, increasing the company's uranium reserves, resources and uranium production levels by about 30%. The principal Canadian assets purchased by Cameco included a 33.33% interest in the Key Lake and Rabbit Lake uranium mines, a 27.92% interest in the McArthur River mine, and a 20% share in the Midwest mine.

Future Production Centres

Of the uranium mining projects in Saskatchewan that have cleared the environmental review process, only the McClean/Midwest Joint Venture project is being developed as a single new production centre. The remaining projects under development will extend the lives of the existing production centres. Cigar Lake will provide feed to the McClean Lake and Rabbit Lake mills, and McArthur River will extend the life of the Key Lake mill. Beyond these Saskatchewan projects, Kiggavik in the Northwest Territories is the only other project currently envisaged as an additional production centre in Canada, but it is unlikely to proceed until well into the next decade.

RENEWABLE ENERGY

Canada is the world leader in hydro-electricity with a production of 327 TWh in 1998. On a national basis, hydro-electricity accounts for about 60% of electricity production and 13% of total primary energy production. Non-hydro renewable energy sources also play an important role, representing another 4.5% of Canada's primary energy production. Most of the non-hydro renewable energy is bio-energy, mostly the combustion of wood waste by the pulp and paper and sawmill industries to generate industrial steam and electricity, and, to a lesser extent, the combustion of wood for residential and commercial space heating. Other renewable energy sources are on a smaller scale but are significant developments. For example, Le Nordais, a 100 MW wind farm in Québec, began operating in 1999.

The federal government is encouraging the development and use of emerging renewable energy sources through tax incentives and departmental activities related to research and development, and market development. There are two

major tax incentives to encourage investments in renewable energy electricity production. Flow-through share financing is available for early intangible expenses under the Canadian Renewable and Conservation Expense category that was created in the 1996 federal budget. Also, production equipment may be eligible for accelerated write-off under the capital cost allowance Class 43.1 which offers a 30% rate on a declining balance.

The federal government has also been supporting the use of "green power" (electricity generated from renewable energy sources) by purchasing wind-generated electricity for use in federal government buildings. For example, in January 1998, an agreement was reached between ENMAX of Calgary and Natural Resources Canada and Environment Canada for ENMAX to supply 12 million kW hours annually of wind- and biomass-generated electricity to power all of the departments' buildings in Alberta.

In recent years, the main thrust of Natural Resources Canada's support to emerging renewable energy has been through financial and technical support to research and development activities by industry. To complement this support, the department undertakes a series of market development activities, including market assessment studies and consumer awareness initiatives. In April 1998, the department enhanced the scope of these activities significantly by introducing the *Renewable Energy Deployment Initiative* (or REDI). This three-year C$ 12 million programme aims at encouraging heating and cooling from renewable sources. The core measure under REDI is a 25% financial incentive to cover the cost of purchasing and installing certain types of solar and biomass heating systems. Other measures under REDI include the development and implementation of marketing and industry infrastructure initiatives in co-operation with the supply industries.

Also announced in 1998 was the Renewable Energy in Remote Communities programme, which aims at helping decision-makers in Canada's 300 off-grid communities give proper consideration to renewable energy alternatives. As part of this programme, the department has developed and distributed RETScreenTM, a pre-feasibility analysis software for eight different types of renewable energy investments. The software was developed at a cost of about C$ 1 million and is available free on the Internet (http://retscreen.gc.ca) or on disc. The Internet version provides links to equipment manufacturers and to NASA weather data.

CRITIQUE

Electricity

The provinces are taking the lead role in regulatory reform.

In Canada, the electricity sector has been organised as a monopoly operating largely within provincial borders. Provinces generally own the utilities and regulate their activities. On average, in excess of 90% of a provincial utility's business falls within the province. Not surprisingly, the provinces are taking the lead role in regulatory reform.

The provinces generally consider reform of the electricity sector is necessary and are addressing the issues. Most provinces have undertaken studies and carried out public consultation processes in planning and implementing restructuring plans. However, the pace of restructuring varies according to the specific circumstances in the province, for example the potential for competition, potential stranded generating assets, and interconnections with other jurisdictions.

In most provinces, a single utility is dominant. Only in Ontario are there firm plans to reduce the market power of the dominant utility. In all other provinces, including Alberta, the existing utilities are likely to remain under present ownership and management. In Alberta, the largest utility is privately-owned and hence divestiture is problematic. The principal obstacle to achieving effective competition is the number of market players able to influence the price in markets dominated by a single, or a few companies.

Alberta has an innovative plan to overcome the limited number of market players.

In Alberta, the plan to lease generating units to marketers is an imaginative response to overcome three barriers to developing competition in the province: the limited number of competitors in the market, the dominance of TransAlta, and the decision not to require TransAlta to divest. The plan seeks to divest management decision-making by individual generating units, while allowing the units to remain owned and operated by the utilities. A simpler and more certain solution to encouraging competition along conventional lines would be to have TransAlta divest some of its generating assets, as has been proposed by some industry consumers[13].

The Alberta plan may fail to deliver true competition, and yet give the appearance of competition without its benefits. Some marketers may participate fully, while high-cost marketers may bid strategically to ensure that they can generate continuously at the ruling bid price. Strategic bidding would be a greater problem if a single marketer controlled despatch of significant base-load and peaking capacity. In these circumstances, the pool price would tend to rise to the cost of the marginal producer. There may be insufficient incentive for the high-cost generators to reduce their costs since each marketer's costs are largely set by the price paid for leasing the generating unit. The outcome will depend in large measure on the relationship established between individual marketers and "their" generating unit through the power purchasing agreement, and the accuracy of the successful bids for the generating units. If the marketer is able to influence management decisions affecting the costs of the generating unit (for example by successful performance incentives in the power purchasing agreement), then the fixed cost structure set by the bids for units may not be a constraint. Possibly, also,

13 Divestiture of private assets has been required in some states of the US, in the UK, and in Italy, for example. Privatisation of separated business units has been effective in the Australian State of Victoria. Divestiture was considered in Alberta but rejected because provincial law and the federal Charter of Rights could have been used as an impediment, possibly delaying deregulation by litigation.

later sales of leases for generating units may help to ensure that pool bid prices do reflect the true generating costs of generating units. To be successful, the managers of the individual generating units must have incentives to reduce costs and act competitively. There will be a strong countervailing tendency for each generating unit to continue to be loyal to the revenue maximisation objective of TransAlta and its shareholders. In these circumstances, each generating unit may seek to maximise its output at the prevailing pool price. Any attempt by the generating unit to improve its market share may be discouraged by the owner (as opposed to the marketer) if it results only in the transfer of market share between TransAlta-owned generating units. In circumstances where expanding market share is encouraged, it may result in enlargement of the TransAlta market share. Even if there are incentives for generators to innovate and improve efficiency, the benefit may be retained by the generator, and not passed through to marketers or consumers in the form of lower prices, unless significant independent capacity emerges to create some competitive pressure.

Once bidding for generating units takes place, marketers will be a new group of players to consider in any further revision of the market. Shorter periods for supply contracts between generating units and marketers would allow more flexibility for the government to respond in the event of failure to achieve competition.

The Ontario plan follows a more conventional approach to developing competition.

The Ontario reform proposal is a more conventional route to developing a competitive electricity market. The outcome will depend on the speed with which Ontario Power Generation Inc. (OPG) complies with its requirement to reduce market share and with the Ontario market's ability to attract new entrants. OPG currently has 90% of Ontario generating capacity and accounts for about 85% of Ontario requirements. Within 10 years of market opening (targeted for late 2000) OPG is required to reduce its effective control over generation supply options to a level that is no more than 35% of the Ontario market. With about one-third market share, and an established position in the market, OPG could continue to be the dominant player. The early divestment of marginal plants will be a critical change in the structure of the market and should be a focus of attention of the government in monitoring progress. Two comments contained in the final report of the Market Design Committee summarise the key areas that will be major determinants of success in establishing competition and bringing the benefits to consumers:

> "It will be critical, as the market unfolds, for government to monitor the market structure and to work closely with the Ontario Energy Board and others to ensure that the fledgling market is not undermined by market abuses. This applies not only to generation but to all other parts of the electricity industry."

> "It will be essential for government, the Ontario Energy Board, and others, to ensure that substantial, well-designed consumer education programs are in place, so that end-use customers know what is happening, and understand their rights and options."

An effective consumer education programme would ensure that consumers are able to exercise effective choice, which is fundamental to the development of strong and dynamic retail markets. Ontario launched an extensive consumer education programme in February 2000.

Reform proposals in other provinces are far less advanced.

Reform in other provinces is not comparable to the policies adopted in Alberta and Ontario. In all cases, a dominant generator is left essentially unchanged, and the prospects for competition developing, except by interprovincial trade, are limited. In the largest provincial electricity market, Québec, the policy is to retain Hydro-Québec as the exclusive property of the Québec government, and to make it the cornerstone of an industrial strategy aimed at making Québec a major energy hub. The industrial development objective is not necessarily incompatible with a liberalised electricity market, but it does suggest that a higher level of government direction to the utility could be expected, and that market principles may be secondary in determining the utility's behaviour and pricing. Intervention to achieve industrial development objectives could reduce economic efficiency and increase the cost borne by the community in the long run.

In some provinces, retail competition does not appear to be a policy objective (for example, it is prohibited in Manitoba), and the regulatory mechanisms in some provinces are not likely to stimulate change. In Québec, for example, the government continues to play an influential role in regulation that may inhibit the development of competition. In time, those provinces which trade with the US may be encouraged to introduce further reforms as US requirements are extended to ensure fair competition in the US market. Otherwise, reform in provinces other than Alberta and Ontario may not progress much further than at present unless provincial consumers press for electricity prices to be determined by competition.

The federal government has taken an important role to date.

The federal government encouraged consideration of electricity restructuring and increased trade in releasing a study by the National Energy Board in 1994 on inter-utility trade in electricity. Federal and provincial governments co-operate in areas involving interprovincial and international electricity restructuring issues. For example, federal and provincial energy ministers reached agreement on open, cross-jurisdiction, non-discriminatory transmission access, and established a federal-provincial working group to advise on the implementation of mandatory reliability standards for bulk power systems that would be compatible on a North American basis.

Federal-provincial energy ministers meet annually to discuss energy issues of common interest, and issues related to electricity restructuring have been on recent agendas. Many issues arise from expanding trade with the US, and the need to adjust the regulatory framework to the increasingly liberalised market. Thus, the need to move to mandatory reliability standards from the current voluntary system stems from the entrance of new market participants and the increasing reluctance of electric utilities to share information with potential competitors in the emerging

competitive electricity markets. A similar approach might be taken on the wider issue of developing regional markets by, for example, establishing a federal-provincial strategic policy group to monitor the development of competitive regional energy markets.

Change will continue to be influenced by US policy, but Canada's federal government has an important role.

A principal factor for change in the Canadian electricity system is the requirements laid down for entry into the US market. This is clearly an area where the federal government has a policy role because of its responsibilities for international trade. The successful development of competition within the provinces will depend in large measure on the number of competitors with sufficient market power to influence price-setting. The development of interprovincial and international trade could be an important factor in bringing new entrants to provincial markets and ensuring effective competition develops within provincial and regional markets. Again, the federal government has power under the constitution to encourage this development because of its concurrent authority over interprovincial trade. The broad policy objective that the federal government might set would be to encourage the development of regional markets, involving several provinces and the US market. Importantly, such a role would ensure that the benefits of competition are brought directly to Canadians, as well as indirectly through encouraging growth in trade with the US. A first step towards this objective might be to direct the National Energy Board to update its 1994 report on inter-utility trade in electricity.

Establishing strong regional electricity markets should be the objective.

Competitive regional markets would also help avoid problems that might arise from the duplication of investment in generation and transmission, or from sub-optimal investment perhaps giving rise to stranded costs in the longer term. Although there is no single model for electricity reform, some key principles are well established internationally. These include vertical disaggregation of the industry through the separation of responsibility for generation, transmission and distribution; third party access to transmission infrastructure at published prices and on transparent conditions; and the establishment of regulation authorities and system operators independent of short-term political influence and the industry. Other principles are less certain, but are discussed widely. For example, horizontal disaggregation to expand the number of competitors by, if necessary, obliging divestiture. Private ownership is also increasingly regarded as an important factor in making competition effective. Some of these general principles could have particular significance for Canada when viewed from a national perspective. Third party access to transmission, for example, has already been agreed by federal and provincial ministers. Practical implementation of this principle might include access to transmission lines from Churchill Falls through Québec to the US market. Exporting the power in this way would be an alternative, and perhaps more productive use of the electricity generated by a future Lower Churchill Falls project than transmission to Newfoundland.

The federal government might review current reform strategies to set out views on how reform might be undertaken and accelerated. Such a review should have four components:

- Demonstrate the benefits to be gained by effective reform measures.
- Encourage reform where action has not been taken at the provincial level.
- Where reform is taking place, encourage provinces to act compatibly in their region so that regional electricity markets may develop.
- Promote interprovincial and international (US/Canada) trade so that truly integrated regional markets emerge.

Nuclear

Nuclear has suffered a setback because of problems in Ontario and high refurbishment costs.

Canada's successful development and application of CANDU nuclear technology has suffered a setback in recent years with the shut-down of eight reactors in Ontario because of declining performance. Shortcomings are reported to have existed in the management, safety culture and equipment of the utility, as well as in the adequacy of regulation.

Although the Pickering reactors are expected to return to service, the return to service of Bruce A will depend on a number of factors including OPG's success in selling the assets or attracting equity investment. Under Ontario's reform, OPG will be required to reduce its effective control over generation to a level that is no more than 35% of the Ontario market. OPG may retain only the nuclear assets or it may prefer to maintain a more flexible portfolio of generating assets to ensure it can retain its reduced market share against aggressive competitors.

Prospects for nuclear in other provinces are also uncertain because of expected investment costs to maintain performance standards. There are no plans for new plants, although OPG is assessing new and advanced designs.

Nuclear has greenhouse benefits that should be considered.

Nuclear power regulation is a federal responsibility with a particular bearing on energy-environment policy. The federal government should review the implications for greenhouse gas emissions should shut-downs be sustained in the longer term. The greenhouse benefits of nuclear should be considered in any decisions on the future of the plants.

The government role in the nuclear sector needs clarification.

The Canadian Government has played an important role in the development of CANDU technology and government support generally continues to play an important indirect

role in supporting the industry. Many activities at present classified as "nuclear" are, in fact, undertaken to achieve objectives in diverse areas, such as in medicine, industry, export promotion, etc. Not all of these activities are undertaken by the government, although there are close links between the government and industry in undertaking them. Medical and industrial applications are now in the hands of the private sector. It would help clarify the government's role in the nuclear industry if government participation in, or association with, each of these activities were evaluated.

Current institutional arrangements may need to be evaluated. In particular, the role of Atomic Energy of Canada Limited may need to be reviewed. A review should assess critically the need for government participation in current AECL activities with a view to privatising some activities outside AECL's core research activities. A review should aim to:

- Ensure that the Canadian nuclear industry is bearing the full cost of its commercial activities, unsubsidised by government.

- Take advantage of Canadian expertise by stimulating the development of profit-making private industry from some of the activities currently within AECL.

- Ensure that the government role in nuclear research is clearly defined. This aspect is important for priority-setting in research and development, and is discussed further in Chapter 8.

The government's response to the review of final disposal of nuclear waste is an important area where the cost should be met fully by the industry. AECL's proposals for waste disposal foreshadows the establishment of a dedicated fund for nuclear waste management. The fund should meet the full cost of management and disposal and be sourced from industry. The government role should be limited solely to monitoring in the public interest.

Renewables

Canada's electricity system is largely based on renewable hydro.

Renewable energy other than hydro may have a limited role in Canada. There may nevertheless be scope for non-hydro renewables such as wind, biomass and photovoltaics in remote regions, where grid connections are uneconomic. In some remote areas, now relying on diesel, subsidised energy prices are understood to be influencing the choice of fuel for electricity generation. It would be desirable to restructure support for remote areas to ensure that social objectives are met without influencing energy-related choices. In this way, the development of renewable energy might be encouraged without incurring additional cost to the government since renewable energy may be competitive in these areas because of the high cost of delivering diesel fuel. The federal government could initiate such a reform in remote areas under federal jurisdiction and encourage by example similar action by the provinces.

Opportunities for other renewables exist in remote areas.

The starting point should be to determine the most cost-effective form of energy supply for remote areas. A study by CANMET (Canada Centre for Mineral and Energy Technology) notes that diesel-generated electricity in remote areas typically costs about 30 cents per kWh. The study concludes that most forms of renewable energy, with the exception of photovoltaics, are cost-effective in these areas. Of 57 pre-feasibility studies of possible projects, 50% were shown to have a positive internal rate of return, but would not proceed because of a network of subsidies and cross-subsidies which impede market signals. Apart from encouraging the application of renewable energy, rationalising the network of subsidies might have economic and environmental benefits by reducing the use of diesel fuel for electricity generation (currently 1% of Canadian energy consumption).

Renewables other than hydro need more direct forms of encouragement in liberalised markets.

Small-scale cogeneration, and renewables other than large-scale hydro, may be attractive in deregulated markets where investors seek niche markets, including peak supply and provision of ancillary services. To take renewables beyond this level would require some form of support. A variety of mechanisms are in use internationally to promote renewable energy in liberalised electricity markets. Some provinces have established the principle of "green" markets, in which consumers can elect to pay a premium for electricity generated by renewable sources. This is probably the most elementary form of support, involving little or no cost to the government or industry. Any support beyond this level should be compatible with liberalised markets. Support might include, for example, incentives to develop a commercially viable renewable sector, and removal of institutional impediments or market distortions that may undermine the capacity of emerging renewable generators to compete on fair and reasonable terms in contestable energy markets. As one element in a wider strategy for market reform, the federal government should review the range of possibilities and promote those it judges most appropriate to Canada. Provincial agreement should be sought for the introduction of market-based incentives in market reform policies to encourage the participation of renewables in liberalised markets.

RECOMMENDATIONS

The Government of Canada should:

Electricity

- ☐ Analyse the benefits of deregulated electricity and gas markets as part of the wider North American energy market, as a means of encouraging the further development of freely competitive, regional electricity and gas markets to the

retail level. The analysis might include the benefits of retail deregulation, corporatisation versus privatisation, and effective open market arrangements.

☐ Work together with provinces and industry to promote energy market reform on a regional basis and seek provincial agreement to further develop such markets. Consideration might be given to enhancing co-operation mechanisms involving policy officials and regulators, building on existing relationships, to promote interprovincial and international trade in electricity, and to provide advice and analysis of options for individual provinces on issues such as stranded costs, establishment of independent system operators and other necessary industry structure and regulatory mechanisms.

☐ Consider options to address the issues raised by multiple regulators setting and enforcing standards in multiple jurisdictions for the interconnected grid in an increasingly integrated North American market.

☐ Discuss with the provinces the role of consumer protection in deregulated markets, including requirements for the provision of adequate information to consumers to ensure informed choices are made, measures to regulate residential marketing practices, and supply in the last resort.

☐ Discuss with the provinces the harmonisation of domestic electricity market legislation as a means of encouraging a regional approach to investment and market development generally.

☐ Review the adequacy of information on emerging gas transmission capacity requirements with the objective of ensuring timely and efficient expansion of gas infrastructure by private parties.

Nuclear

☐ Review the management of Atomic Energy of Canada Limited, and the rationale for continuing government participation in commercial activities under AECL. A review should aim to:

a) ensure the Canadian nuclear industry continues to bear the full cost of its activities, unsubsidised by government;
b) take advantage of Canadian expertise by stimulating the development of profit-making private industry from activities currently within AECL;
c) ensure that the government role in nuclear research is clearly defined.

☐ Move quickly to confirm and implement a policy on nuclear waste disposal, and ensure the implementation of the present policy goal of passing the full cost on to the industry.

☐ Ensure that decisions on the future of existing nuclear power plants take into account the greenhouse gas emissions benefits expected from their continued operation.

Renewables

☐ Monitor the impact of energy pricing reform in remote communities to determine its impact on the development of renewables.

☐ As one element in a wider strategy for market reform, seek provincial agreement for the introduction of market-based incentives in market reform policies to encourage the participation of renewables in liberalised markets.

7

OIL, GAS AND COAL

OIL

Industry Structure

Private companies undertake petroleum exploration and production under licences granted by federal and/or provincial government authorities. About half the industry is foreign-owned, with a few multinational oil companies dominating both its upstream and downstream operations. It is estimated that over 95% of Canada's conventional oil and gas has been found. It is being developed and produced primarily by the 170 member companies represented by the Canadian Association of Petroleum Producers. Many smaller explorers and producers are also active (over 600 in Alberta, for example), and are represented by the Smaller Explorers/Producers Association of Canada. The smaller explorers and producers are generally Canadian-owned and controlled.

The federal government has an 18% interest in Petro-Canada, which was created as a government enterprise in the 1970s. The government interest has been privatised progressively since the early 1990s and further privatisation is planned when market conditions are suitable. The federal government and some provinces have also kept an interest in some smaller resource companies and energy projects.

Most Canadian oil production is in western Canada, principally in Alberta. The largest population and industrial centres generating most petroleum demand, however, are in the eastern provinces of Ontario, Québec and the Atlantic provinces where most of the refining capacity is located. For economic and logistic reasons, Québec and the Atlantic provinces are dependent on foreign sources of oil. Ontario also has access to imported oil with the reversal of the pipeline between Sarnia (where much of Ontario's refining capacity is located) and Montréal. In 1998, production of crude oil and equivalent hydrocarbons reached around 2.1 million barrels per day (mbd). More than half the volume produced (1.337 mbd) was exported to markets in the US (mainly in the US Midwest). Around 754 thousand barrels per day (kbd) were imported into eastern Canada (mainly Québec and the Atlantic provinces), resulting in net exports of 579 kbd, or 27% of production.

Oil is shipped to domestic and US markets through three main pipeline systems: the Enbridge pipeline (formerly named Interprovincial), which delivers 1.7 mbd of oil from Edmonton into the US Great Lakes region and Ontario; the new Express pipeline, which delivers crude from Alberta into Wyoming and onward via its Platte pipeline connection into Illinois; and the Trans Mountain Pipe Line, which delivers oil mainly from Alberta west to Vancouver, the Puget Sound region of the US, and offshore through port facilities at Burnaby.

Exploration and Production

Changes in the royalty rate structure in British Columbia in 1998 contributed to improving drilling activity in this province. Although the number of wells drilled in Canada decreased significantly in 1998, drilling activity increased in British Columbia from 616 wells drilled in 1997 to 683 in 1998. The number of wells drilled in Canada was 10 781 in 1998, down from 18 104 in 1997. The royalty regime could play a significant role in the future for exploration activity in British Columbia. Settlement of native land claims in the Northwest Territories also opened the way to expanded exploration activity.

In 1998, because of lower prices, oil exploration in the Western Canada Sedimentary Basin slowed and emphasis shifted to natural gas. However, the East Coast offshore regions and onshore areas north of the 60th parallel saw some increased exploration and development.

On provincial lands, the relevant provincial government licenses oil production in accordance with its constitutional responsibility for conservation and management of the resource. In the Atlantic offshore areas, production is licensed by joint federal-provincial management bodies, the Canada-Newfoundland Offshore Petroleum Board and the Canada-Nova Scotia Offshore Petroleum Board. In onshore areas of northern Canada, production licensing is performed by the National Energy Board under contract to the territorial governments of the Yukon and Northwest Territories.

Conventional light crude oil[14] production increased in 1998, primarily from the Hibernia field offshore Newfoundland. The Hibernia field started production in late 1997 and in 1998 completed its first full year of production. The field is conservatively estimated to contain 666 million barrels of recoverable oil. The field is being operated by a consortium of six companies, including an 8.5% share held by the Government of Canada. Production at the project commenced in November 1997. Production in 1999 was limited by technical problems. The building of production facilities for the Terra Nova offshore field is underway, and delineation drilling at the Hebron and Whiterose fields is imminent.

In 1998, synthetic crude, pentanes plus and bitumen production also rose. However, conventional heavy crude oil production declined as a significant number of wells were shut-in because of low prices.

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14 This report uses terminology used in Canada, but not necessarily elsewhere. The term "conventional" highlights the difference between regular crude that is relatively easily accessed and either (1) crude that is located in less accessible locations (for example offshore continental shelfs) or (2) "synthetic" crude that is produced by upgrading. Upgrading is accomplished by either removing carbon (for example by coking) or adding hydrogen (for example hydro treating or hydro cracking). Synthetic crude has some special characteristics. It has virtually no impurities and bottoms content compared with regular crude that contains a full spectrum of molecules. Bitumen, in the Canadian context, is extra heavy crude (i.e., 12 API); it does not flow under normal conditions. Bitumen is either mined or produced *in situ* (steam-assisted gravity drainage or cycle steam stimulation) from oil sands, also referred to as tar sands, and is blended to make it transportable, or coked or upgraded to produce "synthetic" crude. Bitumen is not kerogen, the hydrocarbon found in oil shale.

The oil sands segment of the industry continues to provide the impetus for increases in production. To December 1999, there have been announcements of investments totalling about C$ 24 billion to develop projects producing up to 1.2 mbd. Natural Resources Canada expects these projects to come on stream over a 10-year period. Also contributing to the continuing expansion of the Canadian oil industry are improvements in technology: seismic techniques, horizontal drilling, improved drilling equipment and enhanced oil recovery technologies.

The significance of the non-conventional sources of oil is shown in Table 11, which compares oil sand resources with conventional oil resources, in Table 12 which shows established and potential bitumen resources in Alberta, and in Figure 18, which compares production of liquid petroleum in Alberta from conventional and non-conventional sources.

Table 11
Alberta Crude Oil Reserves, 1998
Billion Barrels

	Oil Sands	*Conventional*
In Place	1 698	
Remaining Ultimate Potential	308	6
Initial Established	45.9	15.7
Cumulative Production	2.8	13.7
Remaining Established	43.1	2

Source: Alberta Energy Utilities Board.

Table 12
Alberta Established and Potential Bitumen Reserves
Billion Barrels

	In Place	*Initial Established*	*Ultimate Potential*
In Situ			
Approved	31.5	2.5	
Disclosed	39.7	3.1*	
Oil Sands Areas	1 543.7	120.2*	245.4
Mining			
Approved	6.3	4.0	
Disclosed	20.1	13.5*	
Oil Sands Areas	151.7	40.3	63.6

* Estimates not yet established by the Alberta Energy Utilities Board.

Source: Alberta Energy Utilities Board.

Oil Demand

Final consumption of oil, primarily for transport, is illustrated in Figure 19.

Trade

In 1997, the National Energy Board issued a Memorandum of Guidance to all companies under its jurisdiction setting out a new procedure to be followed by applicants for long-term oil export licences. These changes are meant to protect the public interest of Canadians by giving domestic refiners an opportunity to purchase domestic crude oil on terms no less favourable than those offered to foreign refiners. They also will give producers more comfort with regard to long-term access to the export market. The procedures are similar to those that apply to natural gas and electricity exports. There are no changes to the application requirements for exports of refined products from Canada.

Permits for short-term exports of crude oil require only that a prospective exporter provide the name and address of the firm, a contact name, and the volume of crude oil to be exported. This information is used essentially for monitoring and entails a minimum administrative burden.

For long-term exports, the National Energy Board has a responsibility to ensure that exports are authorised only after due consideration has been given to meeting the long-term requirements of Canadians. However, the prime function of export licensing is to ensure that Canadian exports to foreign customers are not authorised on terms more favourable that those made available to Canadians. This is considered by the Board to be a fair market test, and not a test of resource sufficiency. The licensing procedures for long-term exports are not intended primarily as a conservation mechanism.

Refining

Total crude oil refining capacity was 1.85 mbd at the end of 1997, down from 2.05 mbd in 1989.

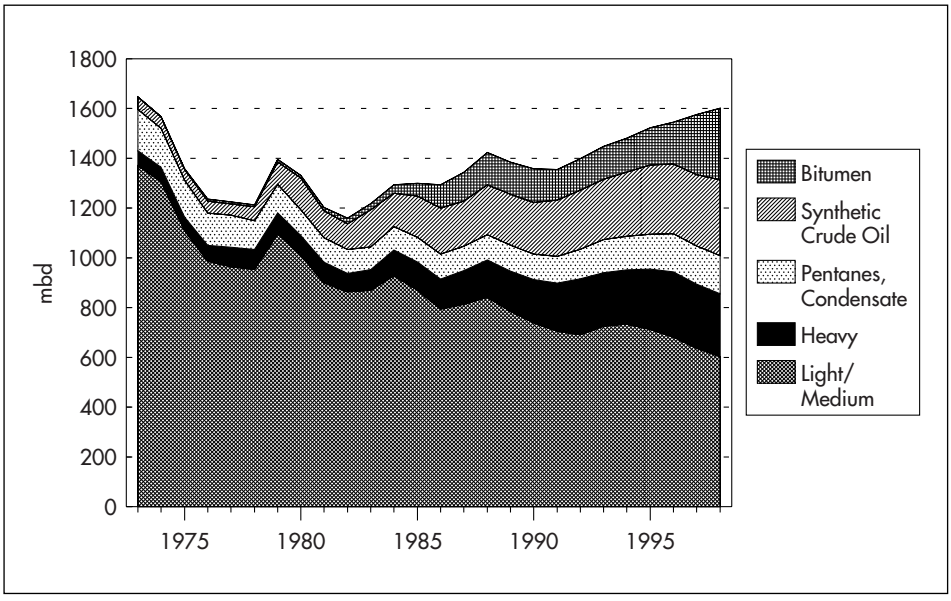
The federal government does little by way of economic regulation of the refining industry. However, federal regulatory changes on fuel specifications for environmental reasons affect the refining industry. Recent developments in this regard include:

- The requirement that from July 1999 gasoline contain less than 1% benzene.

- The implementation, on a national basis, of the following standards for sulphur content in refined products, in parts per million (ppm): average of 150 ppm by 1 July 2002; average of 30 ppm and a maximum of 80 ppm, by 1 January 2005.

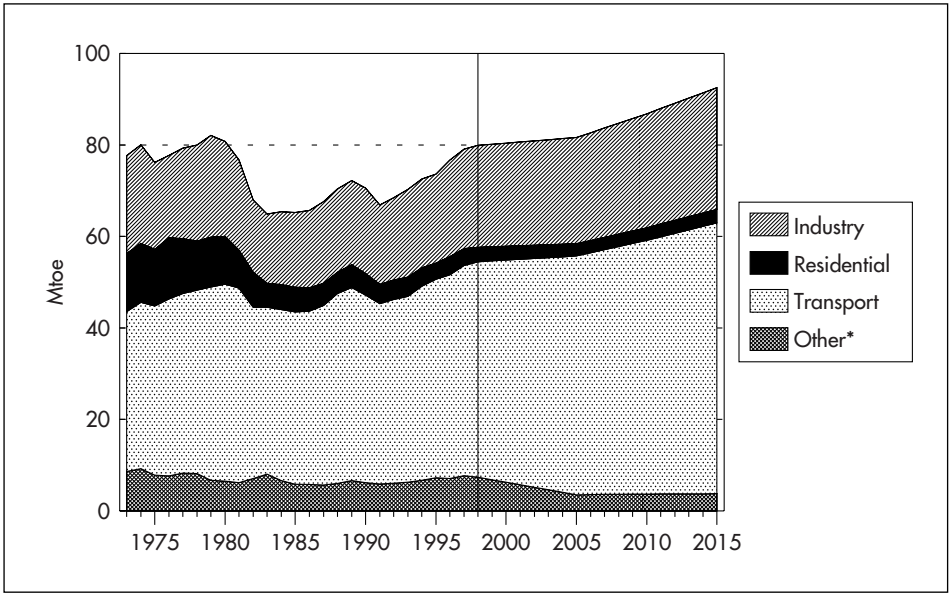
In order to allow sufficient time for refinery modifications, a lead-time of 36 months is expected from the announcement of the new sulphur fuel standard before its

Figure 18
Alberta Total Liquid Petroleum Production, 1973-1998



Source: Alberta Energy Utilities Board.

Figure 19
Final Consumption of Oil by Sector, 1973-2015



* Includes commercial, public service and agricultural sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1999, and country submission.

general application. Most future changes to refinery capacity or additions of conversion plants are expected to be in response to environmental constraints related to fuel quality.

Emergency Response Measures

The Energy Supplies Emergency Act of 1978-79 (amended in 1990) provides the legal instruments to deal with emergencies defined by the IEA's International Energy Program or national oil emergencies. It authorises the Energy Supplies Allocation Board to prepare, develop and maintain in a state of readiness programmes to allocate crude oil and petroleum products, restrain demand for petroleum products, and ration gasoline and diesel fuel in a declared emergency. This is complemented with the Emergency Act and the Emergency Preparedness Act of 1988 that provide statutory powers to develop programmes for national emergencies.

Emergency Reserves

As a net oil exporter, Canada does not have an IEA emergency reserve commitment. All oil stocks held in Canada are commercially-owned. In a declared national emergency, the Energy Supplies Emergency Act would authorise the Energy Supplies Allocation Board to regulate building, storage and disposal of these stocks. The government would decide the threshold level at which emergency measures are activated, in consultation with the oil industry.

Emergency Demand Restraint and Other Measures

In a declared national emergency or in an emergency defined by the IEA's International Energy Program, the federal government would invoke the Energy Supplies Emergency Act to implement the Mandatory Allocation Programme. The Energy Supplies Allocation Board would strive to ensure that limited supplies of crude oil and petroleum products are distributed fairly and equitably to all citizens. The provinces and territories would complement these federal actions with further demand restraint measures.

There is no legal federal authority for demand restraint prior to a declared emergency or prior to emergency defined by the IEA's International Energy Program. Such authority rests entirely with the provinces and territories. At the federal level, media campaigns could be used to encourage voluntary consumption reductions and prevention of hoarding.

Surge production would have a rather limited effect in a crisis. It is typically equivalent to 5% of normal production and could be used only under very severe emergency conditions. Moreover, provincial regulatory agencies could relax best production practices, but could not force oil companies actually to increase production.

Industry Structure

Gas Resources

Canada's natural gas reserves are immense, but spread over a very large number of relatively small pools. The Western Canada Sedimentary Basin, centred on Alberta, accounts for around 70% of discovered resources and almost all production. Large undiscovered resources are estimated in the Canadian frontier areas and offshore Newfoundland. Estimates of the ultimate gas resource of the Western Canada Sedimentary Basin have tended to increase over time as a result of refined assessment methods and improved geological understanding of the basin. Conventionally recoverable ultimate resources in the Western Canada Sedimentary Basin were estimated to be 264-335 Tcf in 1999, compared with 155-182 Tcf in 1986. Ultimate resources include past production, proved reserves and undiscovered potential.

Production

Canada is the third largest natural gas producer in the world with annual production of 173 bcm (1998). While production is principally from Alberta, production in the east is growing in importance and will bring gas to regions currently without gas supply. There are about 1 000 gas producers in Canada, ranging in size from large multinational oil and gas companies to small local firms. The largest 100 companies account for more than 85% of production. The smaller producers tend to sell their output through marketers and aggregators, while many of the larger companies market their supplies directly.

Transmission

As with oil, production is concentrated in the west and principal markets are in the east, necessitating long transmission pipelines. There are eight major transmission pipelines, illustrated in Figure 20. All transmission pipelines, both interprovincial and intra-provincial, are owned and operated by private sector companies, except the gas transmission system in Saskatchewan which is a Crown corporation. The major natural gas pipeline transmission systems are Westcoast Energy Inc. in British Columbia, NOVA Gas Transmission in Alberta and TransCanada Pipelines Ltd. east of Alberta. These systems carry gas both for domestic and export markets. In addition, there are several export-oriented pipelines such as Alberta Natural Gas Company Ltd. and Foothills Pipelines Ltd. There are 16 pipeline interconnections between Canada and the US spread out along the Canada-US border.

Vulnerability to supply disruption arising from long transmission pipelines is mitigated by duplicated lines and substantial upstream storage capacity in western Canada and downstream storage in eastern Canada. Storage acts to mitigate production disruptions and seasonality of demand. Total storage capacity is 12.4 bcm (0.44 Tcf). Downstream storage is slightly higher than upstream storage.

Figure 20
Natural Gas Transmission Network

Source: *Natural Gas Information 1998*, IEA/OECD Paris, 1999.

Development of the transmission network is left to the market. Regional growth patterns will affect the value of capacity along gas pipeline routes and determine whether more capacity is built. Good demand growth in the US Midwest and Northeast is expected to drive major pipeline construction to these regions. In the wider North American market, pipelines are expected to be built from the Gulf Coast in response to demand growth in the South Atlantic. The US West and Rockies also show high growth rates but little pipeline expansion is expected as the region has excess pipeline capacity. The National Energy Board prepares a comprehensive review of Canadian energy markets every two to four years (*Canadian Energy Supply and Demand to 2025*, last published in July 1999), and Natural Resources Canada's Natural Gas Division prepares an annual review of gas markets (*Canadian Natural Gas: Review of 1998 and outlook to 2005*, last published in April 1999). These publications provide information to the market on pipeline capacity.

Distribution

Distribution is carried out by 16 local utilities that have a regulated monopoly over the physical distribution of gas. The largest eight utilities account for about 95% of total local distribution company sales. The largest, Enbridge Consumers Gas, supplies about 25% of customers, and the smallest has less than 10 000 customers. With two exceptions, local distribution companies are privately-owned. SaskEnergy is a Crown corporation in Saskatchewan, and in 1999 Manitoba Hydro (a Crown corporation) bought the private gas distribution company, Centra Gas Manitoba.

Third party access is allowed to the distribution grids and some large industrial customers and power generators can buy gas directly from producers. Some smaller customers in the residential and commercial sectors can also buy gas directly from producers through aggregators, brokers and other middlemen. There are about 4.8 million customers (4.2 million residential customers, 47 000 commercial customers and 18 000 industrial customers).

Retail Competition

Retail gas competition has been developing in a number of provinces for some years, including in Alberta and Ontario. The development was encouraged by falling gas prices and has been slowed by higher prices and by experience with price spikes.

Ontario was one of the first jurisdictions in North America to allow residential and other small volume customers to buy natural gas competitively. Ontario began opening up its gas market in the mid-1980s. Competition in the Ontario market led to a significant drop in the commodity price of gas. Well over a dozen brokers became active in the Ontario market and the distribution utilities estimate that around 40% of residential customers in Ontario buy their gas from an entity other than their distribution utility. As a result of competition, the gas utilities cost of gas fell as well as the price negotiated by aggregators. However, in Ontario, because title was held by the local distribution company, smaller customers could only enter

into buy/sell arrangements with aggregators. While the rebates offered by the aggregators had the same effect as price reductions for consumers and put effective downward price pressure on producers, supply obligations on aggregators were limited and gas utilities were the suppliers of last resort providing customers with supply protection. The legislative impediments that tied title to the utility made the market less effective and competitive, and some consumers complained that they did not receive their negotiated rebates. By allowing title to gas to be held by the supplier, legislation passed in 1998 has permitted the re-emergence of competition. Clarification of the role of distribution utilities as supplier of last resort and setting out the financial obligation for providing supply remain contentious.

Demand

Gas penetration is high in Canada compared with other IEA countries. Demand for gas is illustrated in Figure 21. The big increases in demand are expected to occur in electricity generation using gas and in the industrial sector. These two sectors may account for 59% of gas demand growth in the period 1998 to 2010.

Electricity restructuring will have a continuing influence on demand for gas. Gas use is expected to increase tenfold in central Canada between now and 2020. Growth in gas demand will be driven by increasing use of combined cycle gas generation technology, which will steadily gain market share from other forms of generation. In Canada, by 2010, gas combined cycle generation is forecast to be nearly as important a source of power as coal-steam cycle generation is at present.

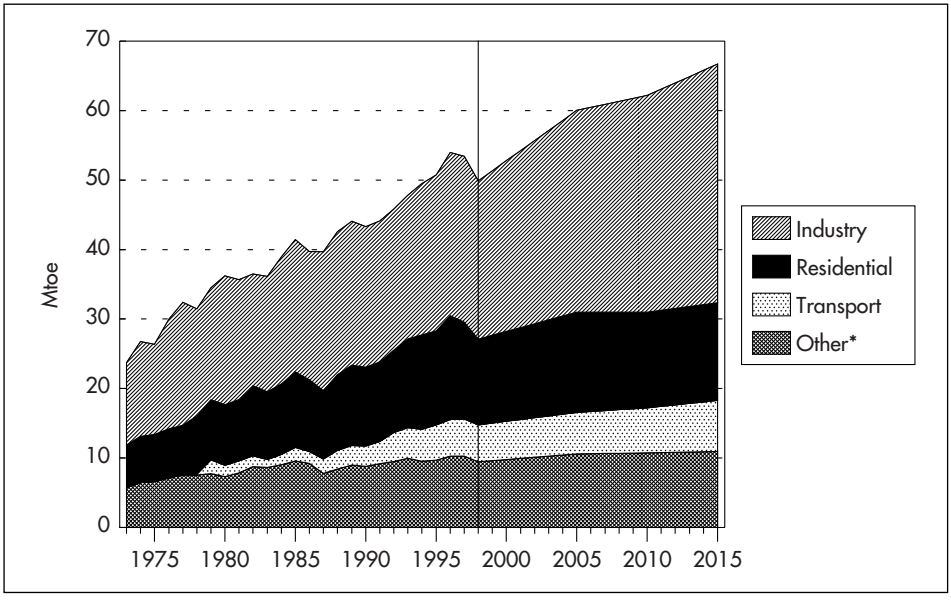
Growth in gas demand is expected to be higher in Canada (2.5% per year) than in the US (1.8% per year) to 2020, but the market will grow as a single North American market. The integration of the Canadian and US markets, under the influence of electricity deregulation and rising gas demand, is expected to require a doubling of gas corridor capacity to over 6 Bcf per day by 2015 between western Canada and the US Midwest. Forecast western Canada flows to domestic and export markets in eastern Canada indicate the need for 1.5 Bcf per day of additional corridor capacity by 2020. An additional 500 MMcf per day of capacity would be required to bring east coast offshore gas to Atlantic Canada and the US Northeast under scenarios postulated by the Canadian Energy Research Institute.

Regulation

The division of responsibilities for gas regulation in Canada is shown in Table 13.

A federal agency, the National Energy Board, is required by the National Energy Board Act to ensure that applied-for long-term natural gas exports will be surplus to reasonably foreseeable Canadian requirements before it issues an export licence. In July 1987, the Board adopted the procedure known as Market-based Procedure to

Figure 21
Natural Gas Consumption, 1973-2015



* Includes commercial, public service and agricultural sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1999, and country submission.

make this assessment. The basic premise of the procedure is that the market will work to satisfy Canadian requirements for natural gas at fair market prices. For this premise to be fulfilled, markets must be competitive, there should be no abuse of market power and all buyers should have access to gas on similar terms and conditions. These conditions were considered to be fulfilled by the Agreement on Natural Gas Prices and Markets signed in October 1985 between the Government of Canada and the three gas producing provinces of British Columbia, Alberta and Saskatchewan. The agreement allowed gas buyers to directly contract for supplies with producers, marketers and other agents at freely negotiated prices.

Table 13
Natural Gas Regulation in Canada

Provincial	*Federal*
• Production	• Interprovincial transmission
• Processing	• Exports and imports
• Intra-provincial transmission	
• Distribution	
• Marketing	

Interprovincial transmission is also regulated by the National Energy Board, which ensures that open non-discriminatory access is provided to all shippers on interprovincial gas pipelines. Interprovincial transportation rates, conditions of access and terms of service are regulated by the National Energy Board. "Settlement agreements" on rates are often negotiated by large groups of shippers directly with the pipeline company. These agreements are then forwarded to the board, which may adopt the recommendation in its rates decision. However, the board sets transportation rates and rates are publicly known and the same for all customers. The board has powers to hold public hearings, if considered necessary.

Local distribution companies are regulated at the provincial level by public utility commissions. The commissions regulate the rates charged by the companies for services, and authorise construction of transmission and distribution lines, including approving and recommending the granting of a franchise area.

Public utility commissions ensure that rates are fair, that gas supplies are secure and that environmental issues are addressed. Most commissions impose minimal supply conditions on agents, brokers and marketers. They are usually required to hold natural gas supply to cover all their direct sales for a number of years. However, if consumers choose to purchase gas from other than local distribution companies, security of supply is less certain. Agents, brokers and marketers are not required to meet any minimum supply requirement to serve residential consumers. In the case of a supply disruption, the commission relies on other agents, brokers and marketers, or on the local distribution company, to use all reasonable means to mitigate any gas disruption. In practice, physical supply is unlikely to be disrupted, but the price at which supply is provided may rise.

Gas Prices

Real gas prices have fallen noticeably since deregulation. Table 14 shows export prices at the Alberta provincial border. The prices are an indication of the development in end-user prices since changes in gas prices paid by the local distribution companies are supposed to be passed on to the end-user.

Gas prices in the industry sector (Figure 22) and in the household sector (Figure 23) are very low on an international comparison.

Trade

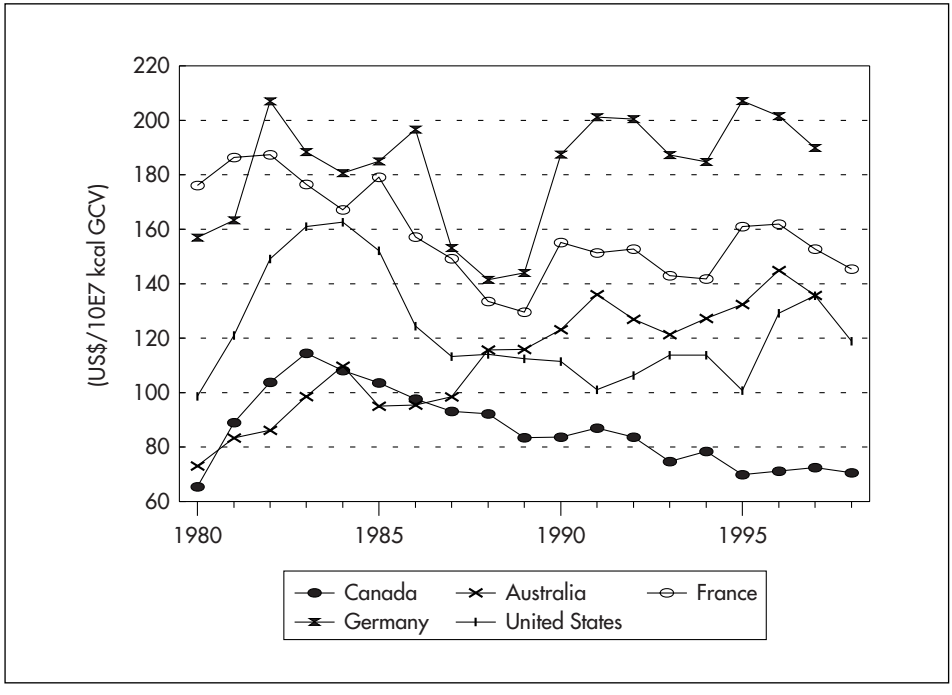
Since deregulation in 1986, sales of Canadian gas have risen dramatically as a result of rising levels of exports. In 1986, 2.9 Tcf of gas was sold, of which 38% was sold in eastern Canada, 36% in western Canada, and 26% exported to the US. In 1998, 5.7 Tcf of gas was sold, of which 21% was sold in eastern Canada, 25% in western Canada and 54% exported to the US. Canada now has a major share in US markets: 50% in the West, 27% in the Midwest and 24% in the Northeast.

Table 14
Alberta Average Gas Price at the Provincial Border

Year	*Price US$/GJ*	*Real US$/GJ*
1985	2.80	2.80
1986/87	1.91	1.83
1987/88	1.77	1.62
1988/89	1.66	1.46
1989/90	1.72	1.45
1990/91	1.65	1.32
1991/92	1.46	1.11
1992/93	1.50	1.12
1993/94	2.14	1.57
1994/95	1.55	1.14
1995/96	1.53	1.10
1996/97	1.85	1.30

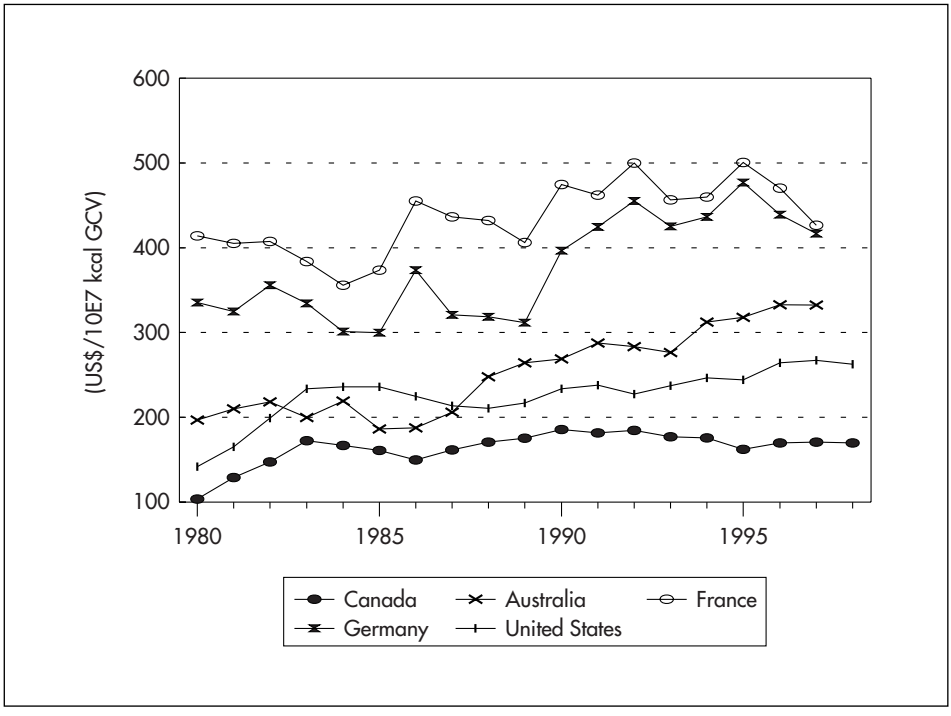
Source: *Natural Gas Distribution*, IEA/OECD Paris, 1998.

Figure 22
Gas Prices in the Industry Sector in Canada and in Other Selected IEA Countries, 1980-1998



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1999.

Figure 23
Gas Prices in the Household Sector in Canada and in Other Selected IEA Countries, 1980-1998



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1999.

Most export contracts are for one-month supply or less and prices are very volatile. Short-term orders currently account for 71% of sales. Prices in the North American market tend to be set by the highest cost marginal Gulf Coast producers.

COAL

Reserves and Production

Coal resources in western Canada extend from lignite deposits in Saskatchewan to sub-bituminous and bituminous grades that cover about three-quarters of the province of Alberta, and continue into northeast and southeast British Columbia. The rank of western Canadian coal decreases from west to east. The mountain region has principally medium to low-volatile bituminous coal. In the foothills and extending into the southwest and northwest plains, the rank decreases to high-volatile bituminous, while in the remainder of the plains, the grade decreases to lignite to the east.

Table 15
Western Canada Coal Reserves
(Mt)

Region	*Measured Reserves*
Mountains	2 860
Foothills	730
Plains	9 270

Source: IEA Coal Research, *Major Coalfields of the World*, 1993.

Table 16
Hard Coal Production in Canada
(Mt)

	1973	*1980*	*1985*	*1990*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998e*
Production	12.3	20.2	34.3	37.7	35.3	36.6	38.6	40.0	41.3	38.3
Percentage of World Production	0.5	0.7	1.1	1.1	1.0	1.0	1.0	1.1	1.1	1.1

e: Estimate.
Source: *Coal Information 1998*, OECD/IEA Paris, 1999.

Table 17
Brown Coal* Production in Canada
(Mt)

	1973	*1980*	*1985*	*1990*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998e*
Production	8.1	16.5	26.5	30.7	33.7	36.2	36.3	35.8	37.4	37.1
Percentage of World Production	1.0	1.7	2.2	2.6	3.4	3.9	4.0	3.9	4.1	4.2

e: Estimate.
* Includes sub-bituminous and lignite.
Source: *Coal Information 1998*, OECD/IEA Paris, 1999.

Industry Structure

Production is almost exclusively from large surface mines, operated by privately-owned companies. The Canadian coal industry is undergoing restructuring. In 1998, the second largest producer, Luscar, acquired the largest producer, Manalta Coal. The merged company (which kept the name Luscar), together with Fording

Coal (now second largest producer) and Teck Corporation (third largest) account for about 93% of Canada's coal production. All three are publicly traded companies.

Smaller producers account for the remaining 7%. These producers comprise two Crown corporations and two privately-owned companies. The Crown corporations are Cape Breton Development Corporation and New Brunswick Coal – a fully-owned subsidiary of New Brunswick Power Corporation, a provincial Crown corporation. The private companies are Smoky River Coal in Alberta and Hillsborough Resources in British Columbia. Both companies are undergoing financial restructuring.

With the exception of support for the government-owned Cape Breton Development Corporation (CBDC), Canada provides no subsidies to the Canadian coal industry. In 1999, the federal government initiated a process to sell the operations of CBDC.

Most of Canada's coal mines are located in the western provinces of British Columbia, Alberta and Saskatchewan (see Figure 24). These three provinces account for some 96% of total production, and about 80% of total employment in the industry. Most mines in Alberta and British Columbia have been developed in the last 20 years. British Columbia is the principal exporter of metallurgical coal, while production from Alberta is used principally for power generation.

Transport costs over 1 000 kilometres from the west coast ports can account for about 50% of total FOB costs. Cost-containment through restructuring has resulted in a high degree of concentration with eight companies now accounting for 99% of total Canadian production. Average production costs are higher than those of many competitors and many mines survive on the basis of long-term contracts with FOB prices in excess of those received elsewhere for metallurgical coal.

Coal Consumption

Coal consumption in Canada is primarily for electricity generation. Demand has been stable since the mid-1980s.

Trade

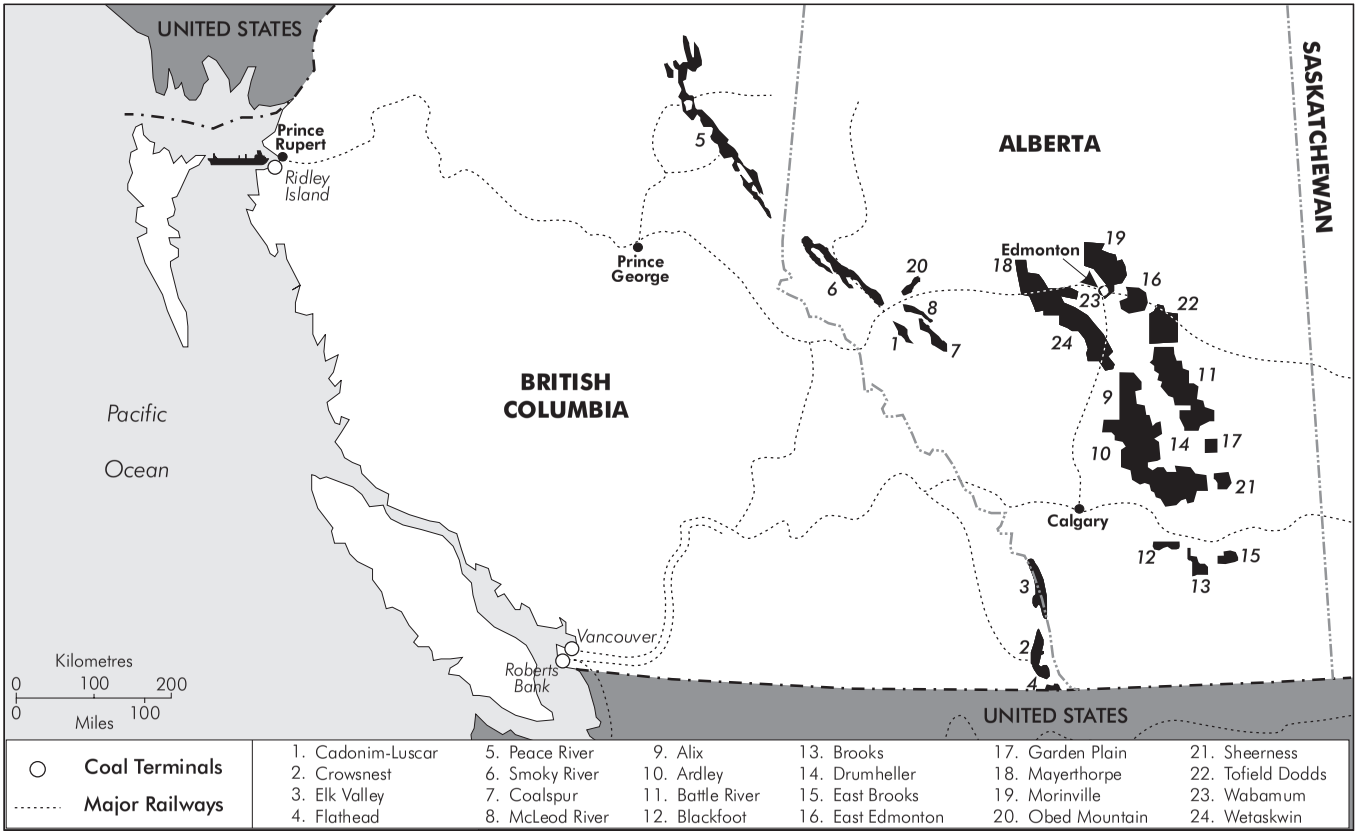
Steam coal exports remain a relatively small percentage of total exports (17%). Steam coal imports exceed steam coal exports, and total imports (almost all from the United States) are about one-third the level of total exports.

Transport and Port Infrastructure

The principal rail routes for Canadian coal exports are to Vancouver (Canadian Pacific railways), and from Alberta and northeast British Columbia to various west coast ports (Canadian National railways). The two principal west coast ports are

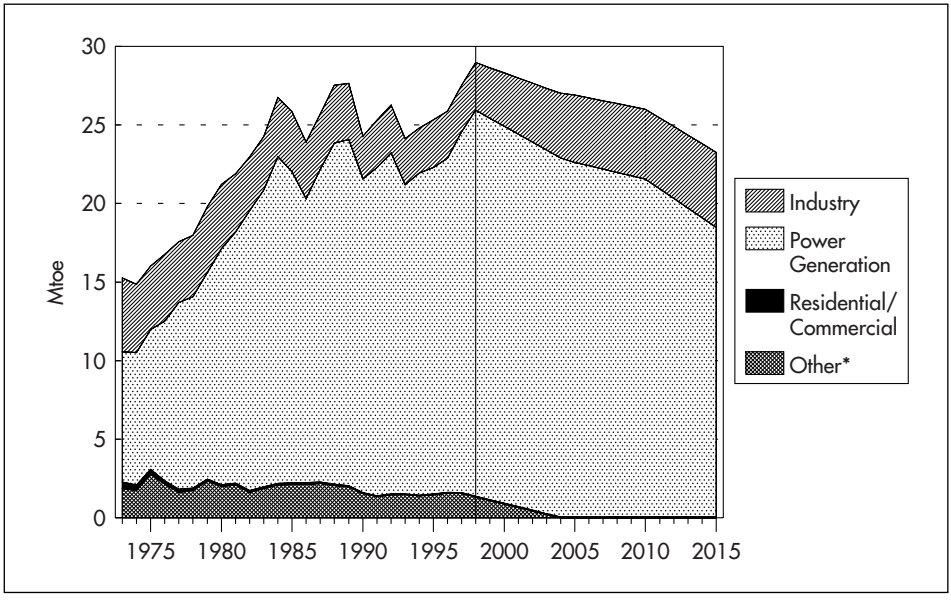
Figure 24

Coal Deposits and Infrastructure of Western Canada



Source: IEA Coal Research, *Major Coalfields of the World*, IEA CR, 1993.

Figure 25
Coal Consumption by Sector, 1973-2015



* Includes commercial, public service and agricultural sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1999, and country submission.

Table 18
Canadian Hard Coal Exports and Principal Destinations
(Mt)

	1980	*1985*	*1990*	*1994*	*1995*	*1996*	*1997*	*1998e*
Total Hard Coal Exports	**15 269**	**27 378**	**31 000**	**31 629**	**33 993**	**34 448**	**36 482**	**34 179**
Coking Coal Exports	**14 127**	**22 483**	**26 860**	**26 997**	**28 564**	**28 722**	**30 044**	**28 348**
Brazil	626	899	1 108	1 144	1 094	1 107	1 207	1 009
Chinese Taipei	211	496	1 059	840	1 289	1 049	1 023	1 140
Italy	48	33	159	772	987	1 211	1 261	958
Japan	10 711	17 026	16 569	15 634	15 798	15 333	15 836	14 254
Korea	1 295	2 041	3 948	4 157	4 364	4 142	4 020	3 977
Turkey			51	222	262	503	597	584
United Kingdom		330	645	808	1 194	1 130	1 306	1 144
Steam Coal Exports	**1 142**	**4 895**	**4 140**	**4 632**	**5 429**	**5 726**	**6 438**	**5 831**
Japan	412	1 516	1 933	2 113	2 483	3 124	2 609	2 528
Korea		1 469	1 205	1 644	1 819	1 242	1 994	2 236

e: Estimate.
Source: *Coal Information 1998*, OECD/IEA Paris, 1999.

Table 19
Canadian Hard Coal Imports
(Mt)

	1980	*1985*	*1990*	*1994*	*1995*	*1996*	*1997*	*1998e*
Total Hard Coal Imports	15 634	14 579	14 111	9 172	9 735	11 938	14 151	16 517
Coking Coal Imports	6 389	6 188	4 996	4 122	4 412	4 998	4 301	4 598
United States	*6 389*	*6 188*	*4 992*	*3 910*	*3 992*	*4 833*	*4 301*	*4 598*
Steam Coal Imports	9 245	8 391	9 115	5 050	5 323	7 165	9 850	11 919
United States	*9 245*	*8 391*	*9 082*	*5 027*	*5 162*	*6 333*	*9 360*	*11 453*

e: Estimate.
Source: *Coal Information 1998*, OECD/IEA Paris, 1999.

Ridley Island at Prince Rupert, and Roberts Bank, which is also an outlet for coal in from the Powder River Basin and other areas in the United States.

CRITIQUE

Oil

Growth will depend on the success of syncrude production from oil sands.

The medium- to longer-term outlook for Canada's conventional oil industry is uncertain. Production may stabilise or fall from current levels because of declining reserves of conventional oil. Seismic work and licence applications have both fallen and some drilling is now directed towards gas. The National Energy Board has reported a very high decline rate from current fields. High levels of exploration and production drilling will be necessary if production levels are to be maintained.

The oil sands companies, led by Syncrude and Suncor, are able to produce light synthetic crude at a high fixed cost, but low variable cost. Unlike conventional oil, production from oil sands is at a fixed rate from a known resource, often using conventional truck and shovel techniques. The producers expect to be economic with oil prices at or above US$ 12 per barrel. Because of the scale of the operations, producers necessarily plan over an extended period and do not respond to short-term movements in the price of oil. The huge forecast expansion in output will have local environmental impacts and contribute significantly to growth in Canada's greenhouse gas emissions because of the high energy input (from gas) to produce syncrude.

Growth in oil output will also be supported by production of bitumen, natural gas liquids associated with the production of natural gas, and by the output of conventional oil from the Hibernia field and other new offshore fields.

Streamlining procedures has been beneficial.

The federal government has continued to streamline licensing procedures for exploration and development of oil and gas. Licensing procedures generally rely on the market to allocate Canadian supply where it is most advantageous. As a result, the regulatory framework places less emphasis on economic regulation and more emphasis on environmental and safety regulations. Project proponents are expected to consult broadly with stakeholders on such matters as environmental issues before applying for a certificate of public convenience and necessity. This is intended to bring forward issues and reduce the time taken for the formal application process.

Pipeline licensing procedures strive to avoid duplication between federal and provincial roles. The federal government has jurisdiction over international and interprovincial lines, whereas the provinces have jurisdiction over intra-provincial lines.

Export procedures have not disadvantaged Canadian consumers.

Oil export licensing procedures give domestic refiners an opportunity to purchase domestic crude oil on terms no less favourable than those offered to foreign refiners. They also give producers long-term access to the export market. Recent amendments to oil export licensing regulations should make it easier for Canadians to enter into long-term export arrangements with foreign purchasers of crude oil and improve the market for Canadian oil.

Reduced reporting requirements place greater reliance on the market.

Canadian oil exporters will benefit from streamlined reporting requirements when applying for long-term export authorisations for crude oil. However, the government will have less information on the supply of Canadian oil to be exported. These changes place a higher degree of reliance on the market to allocate Canadian supply where it is most advantageous.

Natural Gas

Market-based policies have worked well.

Canada and the US are properly considered as a single market. Prices are determined by marginal production from the US Gulf Coast (reflecting maturity of the fields). Canadian production is lower-cost than any US source. Market-based regulation and government policy, allowing short-term export orders to grow, are sensible responses reflecting changes in the market and should benefit Canada. Since estimated reserves are increasing as knowledge of the resource expands, the policy cannot be challenged on grounds of security of supply.

Liberalising the market has corrected the problems of market clearing experienced before market reforms were introduced. Driven by electricity restructuring in

Canada and the US, gas demand is expected to grow strongly as generators turn to lower-cost, flexible gas combined cycle generation technology. This will have important implications for transmission capacity within Canada and linking the Canada and US markets.

Consumer protection measures would assist the smooth transition to liberalised retail gas markets.

The supply portfolios of the local distribution companies have become increasingly short-term over recent years. Some contracts extend to 10-15 years, but the planning horizon of the distribution companies tends to be much shorter. The major part of the volumes supplied are delivered under one-year contracts where prices are renegotiated every year. Most such contracts also reflect monthly pricing variations in the North American gas market, rather than fixed prices, and most companies have implemented risk management strategies to manage price volatility. It will be important for the smooth transition to a fully liberalised retail gas market that consumers understand the risks involved in purchasing gas and that they are offered protection from price volatility. This might involve, for example, price premiums to purchase security. Experience in the liberalised UK retail gas market shows that marketing practices may need to be regulated and provisions made for householders, in particular, to receive mandatory information on prices and conditions of contracts for gas supply. Competition between distributors on price alone may lead to local distribution companies losing market share to the point where they are unable to ensure back-up supply.

The requirement that local distribution companies provide gas on a firm service basis distorts competitive neutrality: consumers may not be able to effectively exercise choice when faced with uncertain security, while the local distribution companies may not be able to compete with new entrants because of the requirement. The local distribution companies may find their customer base "cherry-picked" by aggressive niche retailers. Governments need to address retailer-of-the-last-resort issues in a manner that is consistent with the operation of liberalised markets, rather than side-stepping the issue by placing the burden on existing local distribution companies. One option that would be consistent with the operation of a competitive retail market would be to determine a retailer-of-the-last-resort through some form of competitive tendering arrangement. Policy on these issues is a matter for the provinces, but the federal government could play a role in encouraging a Canada-wide approach to the issue. Exchange of experience between the provinces could encourage a faster development of retail gas market liberalisation.

Government may have a role in the development of the transmission network.

As with other areas of gas policy, Canada relies on the market to ensure pipeline capacity is planned and constructed in time to meet demand. Generally speaking, other IEA countries would consider that there is a role for government to play in the development of the transmission network to ensure that development is timely and

at minimum cost. Market players are not well placed to see development of the transmission network from a national or regional perspective, and may be discouraged by the risks involved because of long planning horizons, high capital costs and regulated returns.

Planning need not involve a high degree of government involvement. Markets require information to function effectively, and provision of government analyses of demand and supply growth, and the market outlook, could be sufficient for this purpose. The National Energy Board and Natural Resources Canada already provide a considerable amount of information of this nature. Similar work is undertaken by the provinces, such as through the Alberta Energy Utilities Board, and by private companies and associations such as the Canadian Gas Association. It may be beneficial to bring this analytical work together on a regular basis, specifically on the issue of pipeline capacity and planning to ensure that the gas market continues to develop smoothly and that potential for supply disruptions is minimised.

A related market information issue arises in connection with access to the transmission network. The National Energy Board generally accepts the outcome of private negotiations for access to pipelines. Interconnections have not been a significant problem in view of the small number of pipeline owners. The NEB has settled disputes where a negotiated outcome could not be agreed. Nevertheless, in most IEA countries, it is considered desirable for prices and conditions for access to be made transparent to all potential users by publishing reference prices and conditions, against which the results of private negotiations might be compared.

Coal

Changes in the international market underlie change in the economics of coal mining in Canada.

The export market for Canadian coal has always been subject to fluctuations in the market for steel. A more recent indirect driver for restructuring in the Canadian coal industry has been technological change in steel-making. Increasing use of softer coals to replace hard coking coal in blast furnaces, made possible by pulverised coal injection (PCI), has led to Canadian hard coking coal being replaced by PCI quality coal from Australia and South Africa. Underlying change in the Canadian industry are changes in the world market as buyers look more to the spot market in setting contract prices for coal. Japanese price premiums to encourage diversified supply have been eroded because of growing competitive pressure in secondary markets for electricity and steel.

Transport costs are one area where viability could be assisted by policy changes.

As in other major coal producing and exporting countries, Canadian producers have been forced to reduce costs and raise productivity to maintain viability. Transport costs are a major component of Canadian coal export costs, and privatisation of the rail network was thought to have important potential for reducing costs. Rail costs

have fallen as a result of privatisation and competition for bulk commodities, but reduced costs have not necessarily been passed on to users, including the coal industry. A review of the operations of the rail services since privatisation is currently underway. Although this review is principally in the context of transport of grain, coal producers and exporters could potentially benefit. The possibility of opening access to the rail network to third parties has been raised as an option for introducing more effective competition, beneficial to rail users.

Policy on greenhouse gas emissions pose a threat.

In the longer term, the viability of the coal industry will be affected by decisions on policies and instruments chosen to meet Canada's greenhouse gas emissions target. This challenge also faces other fossil fuel extraction industries in Canada, although the precarious viability of the coal export industry makes the challenge all the greater.

Government subsidies for coal production will be eliminated.

The Cape Breton Development Corporation has received federal assistance for some years. Although privatisation is the objective, geological problems have forced the closure of one of the two mines (abandoned in September 1999 after a roof fell). The federal government has introduced legislation that will allow for the sale of the assets of CBDC and provide for its eventual dissolution as a Crown corporation. Federal support totalled C$ 44 million in 1998. Even if closed, federal liabilities would amount to about C$ 500 million.

Canada's natural resource endowment, coupled with efficient and productive private investment, has made possible Canada's role as an energy exporter. Continuing efforts to lower transport costs and raise labour productivity will remain important. As a coal exporter, Canada faces stiff competition in an international market with many existing and potential suppliers. Government policies influencing this outcome transcend the energy portfolios of the federal and provincial governments. Broader industry policies, beyond the scope of this review, will play a critically important part. In relation to the coal industry, creating a competitive rail transport market would be a desirable development.

RECOMMENDATIONS

The Government of Canada should:

Natural Gas

- ☐ Review the adequacy of information on emerging gas transmission capacity requirements with the objective of ensuring timely and efficient expansion of gas infrastructure by private parties.

Note: Recommendations related to both gas and electricity are listed at the end of Chapter 6 and in the summary as recommendations on Market Reform.

Coal

☐ Continue to work towards the sale of the assets of the Cape Breton Development Corporation and its eventual dissolution as a Crown corporation.

☐ Develop a means for establishing genuine competition in rail transport of bulk commodities, including coal.

8

ENERGY RESEARCH AND DEVELOPMENT

OVERVIEW

Through energy research and development the Canadian Government aims to add value to Canada's rich endowment of diverse energy resources by enhancing their contribution to economic competitiveness in a safe and environment-friendly manner. Energy research and development programmes include the promotion of energy efficient, renewable and alternative energy sources and technologies.

Non-nuclear government research and development spending is managed by Natural Resources Canada in partnership with other government departments, other levels of government, the private sector and tertiary institutions. Federal government non-nuclear science and technology policy is implemented by the following means:

- The Program of Energy Research and Development (PERD), managed by Natural Resources Canada's Office of Energy Research (OERD[15]), which is the major source of government funding for non-nuclear public and private research and development.

- Natural Resources Canada's Energy Technology Branch (ETB), which includes the three laboratories in the Canada Centre for Mineral and Energy Technology (CANMET). ETB is the largest federal participant in, and manager of, non-nuclear science and technology programmes. ETB receives a large share of PERD funds.

- The Climate Change Technology Early Action Measures (TEAM) programme, which demonstrates innovative technologies for reducing greenhouse gas emissions. TEAM is administered by ETB.

- A number of other government programmes and laboratories undertaking research, including energy research and development.

- Tax credits which apply to all research and development, including energy.

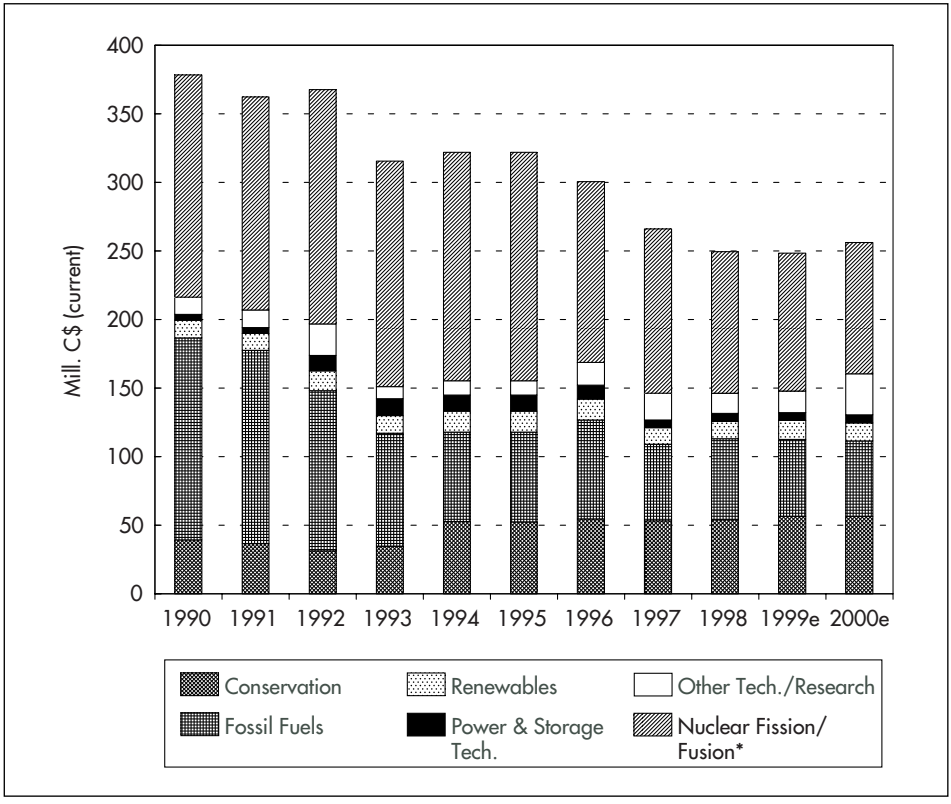
Strategies and directions in the non-nuclear area are laid down in *The 1999 Energy Science and Technology Companion Document*, which translates the current government priorities into corresponding strategies and objectives on energy science and technology. The framework set out in the *Companion Document* is updated when evolving federal energy priorities make it necessary. This process involves broad inter-departemental consultation and ensures that federal science and technology measures are aligned with energy priorities. The climate change challenge and minimisation of local environmental effects, as well as economic and regional development objectives, are in the core of the current *Companion Document*.

15 http://www.nrcan.gc.ca/es/oerd/

All nuclear government energy research and development spending is through Atomic Energy of Canada Limited, a Crown corporation, that focuses on the development and commercialisation of the CANDU reactor technology (see Chapter 6).

In recent years, arrangements for government research and development funds have undergone substantial changes in the level of funding, the administration of programmes and prioritisation. Total government research and development spending (federal and provincial) was cut significantly until 1998, but has been stable since at the level of about C$ 250 million (Figure 26).

Figure 26
Federal and Provincial Government Budget Trends on Energy Research and Development



e: Estimate.
* No fusion funding after 1996.
Source: Country submission.

The budget in 2000-2001 is C$ 256 million, 22% lower than in 1995-96. Provincial government funding diminished even more and now accounts for about 11% of total government spending in 2000-2001. The bulk of the provincial funding is dedicated to oil and gas research and development, particularly oil sands (see Table 20).

Table 20
Estimated Government Energy Research and Development Expenditures, 2000-2001
(C$ Million)

Activities	*Federal Government*	*Provinces*	*Total*	*%*
Conservation	46.1	1.4	47.5	19
Fossil Fuels: Oil, Gas and Coal	35.8	19.1	54.9	21
Renewable Energy Sources	12.9	0.5	13.4	5
Nuclear Fission*	95.4	0.0	95.4	37
Power and Storage Technologies	2.4	0.6	3	1
Other Cross-cutting Technologies/Research	37.6	4.0	41.6	16
Total All Activities	**230.2**	**25.6**	**255.8**	

* AECL support for fission. Fusion is no longer funded.
Source: Country submission.

The budget cuts since 1995-96 have affected nuclear fission and fusion most (a fall of 42%), which had previously remained relatively stable at about C$ 160 million. In particular, fusion research, which until 1995-96 received about C$ 9 million, no longer receives funding from federal energy research and development programmes. Over the same period, fossil fuels research diminished by 25%, especially coal. Conservation research and development expanded by 13% and "other cross-cutting technologies and research"[16] increased by 33%. Renewables research and development diminished by 12%.

THE PROGRAM OF ENERGY RESEARCH AND DEVELOPMENT (PERD)

PERD accounts for almost 30% of federal research and development expenditure and has played the central role in federal energy research and development for the last two decades. PERD funds and co-ordinates federal research and development that is ultimately spent through ten federal departments. These departments use the PERD funds and their base budgets to fund a variety of energy research and development projects with the private sector, universities, provincial governments, research organisations, or internally in their own research laboratories. Natural Resources Canada's own spending share of PERD is about 60%, most of it through

16 In particular, climate change specific research, for example, on carbon dioxide reduction and capture, sequestration in energy plantations, and forestry.

ETB's CANMET laboratories. While PERD projects are intended to focus on applied research and development (short- to medium-term), ETB's activities are intended to combine its funding share with other downstream activities (such as TEAM) and reach towards demonstration and commercialisation[17].

Research and development management and administration has had to become more flexible and more responsive to the government's energy priorities in response to severe budget cuts and new policy priorities such as climate change. As a result, PERD's management and procedures have undergone restructuring. Reflecting the government's energy priorities set out in the Energy Priority Framework, a limited number of "strategic intents" (for example, ensuring economic benefits and reduced environmental consequences from expansion and diversification of oil and gas production) are now defined to guide PERD expenditure. These are broken down into "strategic directions" (for example, science and technology on aspects of onshore oil and gas production with a focus on cost reduction and mitigation of greenhouse gas emissions) and "objectives" (for example, *in situ* and surface mined oil sands production). These PERD directions are closely co-ordinated with industry on both a strategic and a programme level in joint government-industry panels.

Table 21
PERD Energy Research and Development Expenditure
(C$ Million)

Activities	*1997-1998*	*1998-1999*	*1999-2000 Estimated*	*2000-2001 Estimated*
Conservation	15.3	19.9	19.9	19.9
Fossil Fuels: Oil, Gas and Coal	26.4	16.1	16.1	16.1
Renewable Energy Sources	6.5	5.8	5.8	5.8
Nuclear Fission	8.4	0.0	0.0	0.0
Power and Storage Technologies	0.0	0.0	0.0	0.0
Other Cross-cutting Technologies and Research	14.8	16.6	16.7	23.7
Total	**71.4**	**58.4**	**58.5**	**65.5**

Source: Country submission.

Outcomes from projects equivalent to about one-quarter of PERD spending are now evaluated each year against these newly established priorities, intents and directions which are changing over time. Decisions to continue or to liberate the funding for better-aligned purposes and projects are taken on the basis of the evaluations.

17 ETB's own funds outside PERD amounted to C$ 14 million in the 1999-2000 budget. About 60% of ETB's total budget comes from PERD.

The restructuring has led to a more selective support to industries, especially directed towards securing private investment in parallel to public funding, and towards a focus on enhancing the research and development capacity of small to medium-sized enterprises. This has tended to favour projects close to market deployment. Only 5% of PERD funding is now considered long-term. With regard to research priorities, climate change-related issues have become a lead aspect in many areas of PERD support. PERD's priorities are outlined in the box below. Despite limited programme volume, opportunities for defining longer-term perspectives and roles of the programme in science and technology are still sought. One example is the "technology table", a discussion forum on technology and innovation with stakeholders across all sectors, within the National Climate Change Process. Another example is the "Energy Technology Futures" Project that attempts to establish an integrated view of the economic, environmental and social aspects of different long-term scenarios for Canada's energy system. The scenarios help in identifying the most promising greenhouse gas mitigation technologies and will influence strategic plans related to policies, programmes and science and technology investments in support of climate change and sustainable development activities.

NUCLEAR RESEARCH AND DEVELOPMENT SPENDING

Nuclear research and development spending is dedicated to one single user, Atomic Energy of Canada Limited (AECL), a Crown corporation that reports directly to the Minister of Natural Resources. AECL prepares an annual corporate plan setting out its research and development programme for the coming year. This programme is prepared in consultation with other research and development stakeholders, such as the National Research Council of Canada. An independent research and development advisory panel regularly reviews AECL's programme and publishes its results. The nuclear research and development budget is administered separately from other energy research and development such as PERD. The focus of AECL research and development is on the performance and safety aspects of CANDU reactors, the development of next generation CANDU technology, and advanced fuel cycles.

With the sharp reductions in government support after 1995-96, AECL is restructuring and refocusing on commercialisation of its expertise and technology. It now develops, designs and markets power reactors, research reactors and waste treatment technology world-wide (see Chapter 6). These commercial activities currently contribute over C$ 40 million per year to AECL's overall research and development expenditure of C$ 180 million.

GOVERNMENT-INDUSTRY COLLABORATION AND DEPLOYMENT

In parallel to the joint co-ordination of PERD priorities with industrial stakeholders, there has been a trend to establish consortiums jointly funded by industry and provincial and federal governments, such as the fuel cell centre in British Columbia

Priorities in Federal Non-nuclear Energy Science and Technology Support

Strategy 1: Diversifying Canada's Oil and Gas

- Offshore and nothern oil and gas
- Oil sands and heavy oil
- Environmental and safety issues (flares, pipeline integrity, and groundwater and soil remediation)

Strategy 2: Cleaner Transportation for the Future

- Improved urban air quality, including reduced emissions and greenhouse gas production
- Transportation fuels from renewable energy sources
- Improved vehicle and transportation system efficiency
- Fuel cells, electric and hybrid vehicle components

Strategy 3: Energy-Efficient Buildings and Communities

- Building research and development
- Waste recovery and utilisation
- Integration of energy efficiency and renewable energy technologies
- Improvements in sustainable development of communities
- District heating and cooling

Strategy 4: Energy-Efficient Industry

- Innovative products, processes or systems for improved energy efficiency by industry
- Heat management
- Process integration
- Primary agricultural production
- Fisheries
- Forestry
- Mining and metals
- Agricultural and forestry biomass

Strategy 5: Canada's Electricity Infrastructure

- Alternative electric power generation to reduce environmental impacts of Canada's electricity infrastructure
- Efficient conversion of renewable and non-renewable energy to electricity
- Carbon dioxide capture and storage

Strategy 6: Climate Change

- Support for Canadian energy sector's response to impacts of climate change
- Enhanced natural uptake of greenhouse gases

Source: *The 1999 Energy Science and Technology Companion Document*.

and the Petroleum Technology Research Center (PTRC) in Saskatchewan. As a result of budget cuts, ETB's CANMET laboratories have had to move towards increased research and development on a cost recovery basis for the private sector. Uptake of research and development results is thus mainly ensured through attracting industry participation and co-financing. Also, the government laboratories that are increasingly depending on additional income from private parties help to link public research and development spending to private sector activities. Deployment is only to a limited extent directly attempted by dedicated government-funded demonstration, dissemination and deployment schemes, such as the Technology Early Action Measures (TEAM) fund.

INTERNATIONAL COLLABORATION

Collaboration with US Government energy research was strengthened in 1998 through the conclusion of a Memorandum of Co-operation on non-nuclear energy research and development. Projects are organised under Implementing Arrangements analogous to IEA Implementing Agreements. Joint work on fuel cells and fossil fuels are among the first examples under this collaboration.

Canada has a memorandum of understanding with the European Union, which allows Canadian entities to apply with European partners to the EU's 5th Framework Programme. The implementation of this collaboration has been slow. In APEC, Canada participates in technology collaboration activities on clean coal and renewables.

Canada has been a very active participant in IEA technology collaboration activities where it is currently a signatory to 31 Implementing Agreements[18]. In the context of the research and development budget cuts and redirections, Canada reduced some of its participation and became an inactive signatory in some cases, for example in the more technology-focused agreements on fusion such as Fusion Materials and Nuclear Technology of Fusion Reactors.

CRITIQUE

Canada has a focused but flexible non-nuclear research and development programme.

Government research and development spending has undergone substantial restructuring in response to budget cuts and changed government priorities. As a result, federal government research and development spending has increased in

18 The Implementing Agreements are EETIC, EDTE, IEA Coal Research, Coal Combustion Sciences, Enhanced Oil Recovery, Fluidised Bed Conversion, Greenhouse Gas R&D Program, Multiphase Flow Sciences, Bioenergy, Hydrogen, Hydropower, Photovoltaic Systems, Solar Heating and Cooling, Wind Turbine Systems, Advanced Fuel Cells, Advanced Motor Fuels, Buildings and Community Systems, Energy Efficiency in Combustion, Demand Side Management, District Heating and Cooling, Hybrid and Electric Vehicles, Energy Storage, Heat Pumping Technologies, Process Integration, Pulp and Paper, Super Conductivity, Systems Analysis Systems, Fusion Environmental and Safety Issues, and Plasma Wall Interaction in TEXTOR.

transparency and accountability. It is efficiently managed and set up to flexibly respond to government priorities – in particular to assist in developing means to reduce greenhouse gas emissions. The level of co-ordination with industry stakeholders is high. The large reductions in research and development budgets are cause for concern, in view of Canada's energy-intensive economy and the difficult challenge of reducing greenhouse gas emissions in the longer term. The current level of non-nuclear research support should therefore be reconsidered and options for increased spending should be sought.

The flexibility created through the new PERD strategy and evaluation process should assist a sustained support of initiatives with a potential for medium- to long-term pay-off. The contraction of budgets has favoured a focus of government research and development spending on areas where industry money can be leveraged. Uptake and deployment is assisted through private sector initiatives. The extent to which the integration of government research and development with private players is achieved is laudable. A possible downside could be the lack of medium- to long-term research and development, a role that tends not to be of interest to industry. If funding is increased in the future, an increased share of medium- to long-term research and development, and the government role in deployment, should be considered.

Priorities for the total research and development budget (nuclear and non-nuclear) should be developed jointly.

With the increased commercial orientation of AECL towards profit and competition and the comprehensive restructuring of the non-energy research and development prioritisation and management, the two institutionally separated parts of federal government research and development are evolving quickly. Notwithstanding the present institutional separation of nuclear and non-nuclear budget management, an evaluation of the allocation of research and development spending for nuclear and non-nuclear purposes with regard to the overarching government priorities (competitiveness of domestic industry, energy resource diversification, environmental impacts, climate change, etc.) could be beneficial to create an optimal budget allocation. The new practices on the non-nuclear energy research and development budget management could offer interesting insights also for the nuclear part.

RECOMMENDATIONS

The Government of Canada should:

- ☐ Consider giving further support for research and development related to reducing greenhouse gas emissions by reviewing the level of funding for non-nuclear energy research and development in the context of the magnitude of the task facing the Canadian Government to meet its greenhouse gas emissions

target. Consideration should be given to the scope for increased support from government and private sources.

- Maintain a minimum level of sustained medium- to long-term research in the non-nuclear programme. Consideration should be given to expanding the role played by government in deployment initiatives as a means of encouraging the use of new technologies.

- Consider the benefits of setting priorities and allocating funding for nuclear and non-nuclear research and development budgets through a single process.

A

ANNEX

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

		1973	1990	1997	1998	2005	2010	2015
TOTAL PRODUCTION		**198.0**	**273.7**	**364.7**	**365.7**	**439.8**	**460.8**	**491.5**
Coal [1]		11.7	37.9	43.0	40.8	40.1	41.1	40.0
Oil		96.3	94.1	122.3	125.2	163.1	170.9	191.7
Gas		61.4	88.6	137.9	142.3	165.2	179.5	191.9
Comb. Renewables & Wastes [2]		7.8	8.1	9.8	10.1	17.1	18.0	19.1
Nuclear		4.1	19.4	21.5	18.6	23.4	20.3	17.0
Hydro		16.7	25.5	30.2	28.5	30.5	30.5	31.3
Geothermal		–	–	–	–	0.4	0.4	0.4
Solar/Wind/Other [3]		–	0.0	0.0	0.0	0.1	0.1	0.1
TOTAL NET IMPORTS [4]		**–35.4**	**–60.6**	**–122.8**	**–129.6**	**–169.1**	**–178.7**	**–192.7**
Coal [1]	Exports	7.6	21.4	25.3	23.7	21.7	23.0	23.0
	Imports	10.5	9.5	9.7	12.1	8.3	7.9	6.9
	Net Imports	2.8	–11.9	–15.6	–11.6	–13.4	–15.1	–16.1
Oil	Exports	63.1	49.7	84.6	90.7	123.6	128.2	144.9
	Imports	48.8	34.5	47.4	48.3	51.7	54.3	57.1
	Bunkers	–	0.9	0.9	1.1	0.7	0.7	0.8
	Net Imports	–14.3	–16.1	–38.1	–43.5	–72.6	–74.6	–88.5
Gas	Exports	23.1	33.0	67.0	72.8	81.0	88.0	88.0
	Imports	0.3	0.5	1.0	0.7	1.0	1.0	1.0
	Net Imports	–22.8	–32.5	–66.0	–72.1	–80.0	–86.9	–86.9
Electricity	Exports	1.4	1.6	3.9	3.8	6.8	5.4	4.5
	Imports	0.2	1.5	0.8	1.5	3.6	3.4	3.3
	Net Imports	–1.2	–0.0	–3.1	–2.4	–3.2	–2.0	–1.2
TOTAL STOCK CHANGES		**–1.6**	**–4.0**	**–2.5**	**–1.8**	**–**	**–**	**–**
TOTAL SUPPLY (TPES)		**161.0**	**209.1**	**239.5**	**234.3**	**270.7**	**282.2**	**298.8**
Coal [1]		15.3	24.3	27.5	29.0	26.7	26.0	23.9
Oil		81.0	77.1	82.3	82.1	90.6	96.3	103.2
Gas		37.3	54.7	71.2	68.3	85.2	92.6	105.0
Comb. Renewables & Wastes [2]		7.8	8.1	9.8	10.1	17.1	18.0	19.1
Nuclear		4.1	19.4	21.5	18.6	23.4	20.3	17.0
Hydro		16.7	25.5	30.2	28.5	30.5	30.5	31.3
Geothermal		–	–	–	–	0.4	0.4	0.4
Solar/Wind/Other [3]		–	0.0	0.0	0.0	0.1	0.1	0.1
Electricity Trade [5]		–1.2	–0.0	–3.1	–2.4	–3.2	–2.0	–1.2
Shares (%)								
Coal		*9.5*	*11.6*	*11.5*	*12.4*	*9.9*	*9.2*	*8.0*
Oil		*50.3*	*36.9*	*34.4*	*35.0*	*33.5*	*34.1*	*34.5*
Gas		*23.2*	*26.2*	*29.7*	*29.2*	*31.5*	*32.8*	*35.1*
Comb. Renewables & Wastes		*4.9*	*3.9*	*4.1*	*4.3*	*6.3*	*6.4*	*6.4*
Nuclear		*2.5*	*9.3*	*9.0*	*8.0*	*8.6*	*7.2*	*7.5*
Hydro		*10.4*	*12.2*	*12.6*	*12.2*	*11.3*	*10.8*	*10.5*
Geothermal		–	–	–	–	*0.2*	*0.2*	*0.1*
Solar/Wind/Other		–	–	–	–	–	–	–
Electricity Trade		*–0.7*	–	*–1.3*	*–1.0*	*–1.2*	*–0.7*	*–0.4*

0 is negligible. – is nil. .. is not available.

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	1997	1998	2005	2010	2015
TFC	**133.2**	**161.3**	**185.1**	**182.5**	**210.0**	**221.2**	**236.6**
Coal[1]	5.2	3.1	3.3	3.3	4.5	4.7	5.1
Oil	77.6	70.6	79.1	79.9	81.6	86.8	92.5
Gas	23.7	43.3	53.4	49.9	60.0	62.2	66.7
Comb. Renewables & Wastes[2]	7.6	7.8	9.2	9.5	15.7	16.7	17.8
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	18.9	36.0	39.5	39.2	47.4	50.1	53.8
Heat	0.1	0.6	0.6	0.7	0.7	0.7	0.8
Shares (%)							
Coal	*3.9*	*1.9*	*1.8*	*1.8*	*2.2*	*2.1*	*2.1*
Oil	*58.3*	*43.7*	*42.7*	*43.8*	*38.9*	*39.2*	*39.1*
Gas	*17.8*	*26.8*	*28.9*	*27.3*	*28.6*	*28.1*	*28.2*
Comb. Renewables & Wastes	*5.7*	*4.8*	*5.0*	*5.2*	*7.5*	*7.5*	*7.5*
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	*14.2*	*22.3*	*21.3*	*21.5*	*22.6*	*22.7*	*22.7*
Heat	*0.1*	*0.4*	*0.3*	*0.4*	*0.3*	*0.3*	*0.3*
TOTAL INDUSTRY[6]	**52.8**	**63.2**	**73.1**	**73.2**	**92.0**	**98.5**	**106.8**
Coal[1]	4.7	3.0	3.2	3.3	4.5	4.6	5.0
Oil	21.4	18.7	21.8	22.3	23.2	24.9	26.6
Gas	11.9	20.2	23.9	22.8	29.0	31.2	34.3
Comb. Renewables & Wastes[2]	5.7	6.2	7.5	7.7	13.8	14.7	15.7
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	9.1	14.4	16.2	16.5	20.8	22.4	24.4
Heat	0.1	0.6	0.6	0.6	0.7	0.7	0.8
Shares (%)							
Coal	*8.9*	*4.8*	*4.4*	*4.5*	*4.9*	*4.7*	*4.7*
Oil	*40.4*	*29.5*	*29.7*	*30.4*	*25.2*	*25.3*	*24.9*
Gas	*22.5*	*32.0*	*32.7*	*31.1*	*31.5*	*31.7*	*32.1*
Comb. Renewables & Wastes	*10.8*	*9.8*	*10.2*	*10.6*	*15.0*	*14.9*	*14.7*
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	*17.2*	*22.9*	*22.2*	*22.5*	*22.6*	*22.7*	*22.8*
Heat	*0.2*	*1.0*	*0.8*	*0.9*	*0.7*	*0.7*	*0.7*
TRANSPORT[7]	**35.3**	**44.2**	**51.6**	**52.9**	**59.2**	**63.0**	**67.6**
TOTAL OTHER SECTORS[8]	**45.1**	**54.0**	**60.3**	**56.5**	**58.8**	**59.7**	**62.2**
Coal[1]	0.4	0.1	0.0	0.0	0.1	0.1	0.1
Oil	21.3	10.9	11.4	10.5	6.2	6.5	6.8
Gas	11.9	20.2	24.2	21.8	25.0	24.5	25.0
Comb. Renewables & Wastes[2]	1.9	1.6	1.8	1.8	1.9	2.0	2.0
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	9.5	21.2	22.8	22.3	25.5	26.7	28.3
Heat	–	0.0	0.0	0.0	0.0	0.0	0.1
Shares (%)							
Coal	*0.9*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Oil	*47.4*	*20.2*	*18.9*	*18.7*	*10.6*	*10.8*	*10.8*
Gas	*26.3*	*37.4*	*40.2*	*38.6*	*42.6*	*41.0*	*40.2*
Comb. Renewables & Wastes	*4.2*	*3.0*	*3.0*	*3.2*	*3.2*	*3.3*	*3.3*
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	*21.2*	*39.3*	*37.9*	*39.4*	*43.4*	*44.7*	*45.5*
Heat	–	–	–	*0.1*	*0.1*	*0.1*	*0.1*

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	1997	1998	2005	2010	2015
ELECTRICITY GENERATION[9]							
INPUT (Mtoe)	**36.1**	**70.7**	**82.5**	**81.7**	**89.3**	**89.2**	**90.6**
OUTPUT (Mtoe)	**23.2**	**41.4**	**49.3**	**48.3**	**55.2**	**56.9**	**60.5**
(TWh gross)	270.1	481.9	573.5	561.7	642.1	661.4	703.9
Output Shares (%)							
Coal	*12.9*	*17.1*	*17.3*	*19.1*	*15.6*	*14.4*	*11.7*
Oil	*3.4*	*3.4*	*2.3*	*3.3*	*0.7*	*0.7*	*0.6*
Gas	*6.0*	*2.0*	*3.7*	*4.6*	*11.8*	*16.8*	*24.3*
Comb. Renewables & Wastes	*–*	*0.8*	*1.1*	*1.1*	*2.5*	*2.4*	*2.3*
Nuclear	*5.6*	*15.1*	*14.4*	*12.7*	*14.0*	*11.8*	*9.3*
Hydro	*72.1*	*61.6*	*61.2*	*59.1*	*55.2*	*53.6*	*51.6*
Geothermal	*–*	*–*	*–*	*–*	*0.1*	*0.1*	*0.1*
Solar/Wind/Other	*–*	*0.0*	*0.0*	*0.0*	*0.1*	*0.1*	*0.1*
TOTAL LOSSES	**31.2**	**48.6**	**54.8**	**55.1**	**60.7**	**61.0**	**62.2**
of which:							
Electricity and Heat Generation[10]	12.8	28.6	32.6	32.7	33.5	31.4	29.8
Other Transformation	1.9	–1.4	–3.1	–3.3	8.6	9.1	10.1
Own Use and Losses[11]	16.5	21.4	25.3	25.6	18.6	20.5	22.3
Statistical Differences	**–3.5**	**–0.8**	**–0.4**	**–3.3**	**–**	**–**	**–**

INDICATORS

	1973	1990	1997	1998	2005	2010	2015
GDP (billion 1990 US$)	340.86	572.67	647.38	666.72	808.90	897.47	1005.54
Population (millions)	22.56	27.79	30.00	30.30	32.60	34.00	35.60
TPES/GDP[12]	0.47	0.37	0.37	0.35	0.33	0.31	0.30
Energy Production/TPES	1.23	1.31	1.52	1.56	1.62	1.63	1.64
Per Capita TPES[13]	7.14	7.52	7.98	7.73	8.30	8.30	8.39
Oil Supply/GDP[12]	0.24	0.13	0.13	0.12	0.11	0.11	0.10
TFC/GDP[12]	0.39	0.28	0.29	0.27	0.26	0.25	0.24
Per Capita TFC[13]	5.91	5.80	6.17	6.02	6.44	6.51	6.65
Energy–related CO_2 Emissions (Mt CO_2)[14]	374.0	424.1	482.2	480.1	530.4	559.4	597.8
CO_2 Emissions from Bunkers (Mt CO_2)	–	2.9	2.9	3.6	2.3	2.4	2.4

GROWTH RATES (% per year)

	73–79	79–90	90–97	97–98	98–05	05–10	10–15
TPES	2.9	0.8	2.0	–2.2	2.1	0.8	1.1
Coal	4.4	1.9	1.8	5.2	–1.2	–0.5	–1.7
Oil	2.1	–1.6	0.9	–0.2	1.4	1.2	1.4
Gas	2.7	2.1	3.8	–4.1	3.2	1.7	2.5
Comb. Renewables & Wastes	–1.6	1.2	2.7	3.3	7.7	1.1	1.2
Nuclear	15.7	6.4	1.5	–13.5	3.3	–2.7	–3.5
Hydro	3.8	1.8	2.4	–5.4	1.0	–	0.5
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	21.9	–	33.4	–	–
TFC	2.4	0.4	2.0	–1.4	2.0	1.1	1.4
Electricity Consumption	4.7	3.4	1.3	–0.7	2.7	1.1	1.4
Energy Production	1.0	2.4	4.2	0.3	2.7	0.9	1.3
Net Oil Imports	–	–	13.1	14.3	7.6	0.6	3.5
GDP	3.9	2.7	1.8	3.0	2.8	2.1	2.3
Growth in the TPES/GDP Ratio	–1.0	–1.8	0.2	–5.0	–0.7	–1.2	–1.1
Growth in the TFC/GDP Ratio	–1.4	–2.2	0.2	–4.2	–0.8	–1.0	–0.9

Please note: Rounding may cause totals to differ from the sum of the elements.

Footnotes to Energy Balances and Key Statistical Data

1. Includes lignite and peat, except for Finland, Ireland and Sweden. In these three cases, peat is shown separately.
2. Comprises solid biomass and animal products, gas/liquids from biomass, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
3. Other includes tide, wave and ambient heat used in heat pumps.
4. Total net imports include combustible renewables and waste.
5. Total supply of electricity represents net trade. A negative number indicates that exports are greater than imports.
6. Includes non-energy use.
7. Includes less than 1% non-oil fuels.
8. Includes residential, commercial, public service and agricultural sectors.
9. Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.
10. Losses arising in the production of electricity and heat at public utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of 33% for nuclear, 10% for geothermal and 100% for hydro.
11. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
12. Toe per thousand US dollars at 1990 prices and exchange rates.
13. Toe per person.
14. "Energy-related CO_2 emissions" specifically means CO_2 from the combustion of the fossil fuel components of TPES (i.e. coal and coal products, peat, crude oil and derived products and natural gas), while CO_2 emissions from the remaining components of TPES (i.e. electricity from hydro, other renewables and nuclear) are zero. Emissions from the combustion of biomass-derived fuels are not included, in accordance with the IPCC greenhouse gas inventory methodology. TPES, by definition, excludes international marine bunkers. INC-IX decided in February 1994 that emissions from international marine and aviation bunkers should not be included in national totals but should be reported separately, as far as possible. CO_2 emissions from bunkers are those quantities of fuels delivered for international *marine* bunkers and the emissions arising from their use. Data for deliveries of fuel to international *aviation* bunkers are not generally available to the IEA and, as a result, these emissions have not been deducted from the national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 1998 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

B

ANNEX

INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

The Member countries* of the International Energy Agency (IEA) seek to create the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants.

In order to secure their objectives they therefore aim to create a policy framework consistent with the following goals:

1 **Diversity, efficiency and flexibility within the energy sector** are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2 Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3 **The environmentally sustainable provision and use of energy** is central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should where practicable have regard to the Polluter Pays Principle.

4 **More environmentally acceptable energy sources** need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of

* Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.

IEA Members wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5 **Improved energy efficiency** can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6 **Continued research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7 **Undistorted energy prices** enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8 **Free and open trade** and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9 **Co-operation among all energy market participants** helps to improve information and understanding, and encourage the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at their 4 June 1993 meeting in Paris.)

C

ANNEX

GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations are substituted for a number of terms.

AECB	Atomic Energy Control Board.
AECL	Atomic Energy of Canada Limited.
APEC	Asia-Pacific Economic Co-operation.
Bcf	billion cubic feet.
bcm	billion cubic metres.
CANDU	Canada Deuterium Uranium nuclear reactor.
CANMET	Canada Centre for Mineral and Energy Technology.
CBDC	Cape Breton Development Corporation.
CHP	combined production of heat and power; sometimes, when referring to industrial CHP, the term "co-generation" is used.
EAE	Energy Efficiency and Alternative Energy Program.
ETB	Energy Technology Branch.
FERC	US Federal Energy Regulatory Commission.
GDP	gross domestic product.
GHG	greenhouse gases (see footnote 4 in Chapter 4).
GW	gigawatt, or 1 watt $\times 10^9$.
LDC	local distribution companies.
LNG	liquefied natural gas.
LPG	liquefied petroleum gas; refers to propane, butane and their isomers, which are gases at atmospheric pressure and normal temperature.
mcm	million cubic metres.
MMcf	million cubic feet.
Mt	million tonnes.
Mtoe	millions tonnes of oil equivalent; see toe.
MW	megawatt of electricity, or 1 Watt $\times 10^6$.
MWh	megawatt-hour = one megawatt $\times$ one hour, or one watt $\times$ one hour $\times 10^6$.
NALC	Newfoundland and Labrador Hydro Corporation.
NEB	National Energy Board.
NO_x	oxides of nitrogen.

NRCan	Natural Resources Canada.
OECD	Organisation for Economic Co-operation and Development.
OEE	Office of Energy Efficiency.
OHSC	Ontario Hydro Services Company.
OPG	Ontario Power Generation Inc.
PCI	pulverised coal injection.
PERD	Program of Energy Research and Development.
PJ	petajoule.
POWEREX	British Columbia Power Export Corporation.
PPP	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, i.e. estimates the differences in price levels between different countries.
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well.
Tcf	trillion cubic feet.
TEAM	Climate Change Technology Early Action Measures.
TFC	Total Final Consumption of energy; the difference between TPES and TFC consists of net energy losses in the production of electricity and synthetic gas, refinery use and other energy sector uses and losses.
toe	tonne of oil equivalent, defined as 10^7 kcal.
TPA	Third Party Access.
TPES	Total Primary Energy Supply.
TW	terawatt, or 1 watt $\times 10^{12}$.
TWh	terawatt $\times$ one hour, or one watt $\times$ one hour $\times 10^{12}$.
UNFCCC	United Nations Framework Convention on Climate Change.
VCR	Voluntary Challenge and Registry Program.

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