CLIMATE OF CHANGE

The Role of Government

A Briefing Paper to the Honourable Paul Martin, September 29, 1997

David Suzuki Foundation

Finding solutions

October 1997

This report is part of a series on climate change produced for the David Suzuki Foundation leading up to the 1997 and 1998 meetings of theConference of the Parties to the UN Framework Convention on Climate Change in Kyoto, Japan (COP 3), and Buenos Aires, Argentina (COP 4). A description of each of these reports appears on the back cover. They are available free to download from the David Suzuki Foundation website: <www.davidsuzuki.org> or can be ordered directly from the address below.

The Author

Dr. Michael Margolick is a Senior Consultant with Global Change Strategies International Inc. He has a BA in Mathematics from Cornell University and a Ph.D. in Mathematics from the University of British Columbia. Prior to joining GCSI, he was the Executive Director of the BC Energy Council and Senior Resource Planning Coordinator for the Corporate Strategic Planning Unit at BC Hydro. He is an Adjunct Professor in the School of Resource and Environmental Management at Simon Fraser University.

with assistance from

Andrew Pape is a sustainable energy consultant in Vancouver, a researcher at Simon Fraser University with the Energy Research Group at the School of Resource and Environmental Management, and a Director with the Solar Energy Society of Canada.

Acknowledgements

The following individuals reviewed earlier drafts of the report, offering many useful comments and suggestions:

- Jim Bruce, Co-chair of IPCC Working Group 3 & Chair of Canadian Climate Change Program Board
- Mark Jaccard, Chair of the task force to implement electricity market reforms in BC
- Erik Haites, Margaree Consultants Inc.
- Professor Richard Schwindt, Department of Economics & Faculty of Business Administration, Simon Fraser University
- Trent Berry and Lee Failing, Compass Resource Management Ltd.

ISBN 1-55054-629-5

David Suzuki Foundation
2211 West 4th Ave., Suite 219
Vancouver, BC, Canada V6K 4S2
Tel: (604) 732-4228
Fax: (604) 732-0752
email: orders@davidsuzuki.org
www.davidsuzuki.org

The Role of Government

This paper provides a basis for designing and implementing a strategic plan to comply with Canada's commitment to cut greenhouse gas emissions.

Under the 1997 Kyoto Protocol, Canada committed to such a plan, agreeing to reduce greenhouse gas emissions to six per cent below 1990 levels by 2008-2012. The Kyoto Protocol is just the first step on the road to much larger cuts in greenhouse gas emissions necessary to reduce the risks of climate change.

By the 1998 climate change conference in Buenos Aires, Argentina, Canadian emission levels had increased by 1.5 per cent since the Kyoto Accord, and the federal government had still not developed an action plan to reduce emissions. Admittedly, developing and following a plan is not simple. The effects of policies are difficult to predict and measure. Individuals, businesses and institutions often do not do what economic theory predicts. In addition, any such plan must be balanced and fair to all sectors.

Yet regardless of the difficulty, Canada's performance is being judged internationally by other countries committed to reducing emissions. If Canada has a commitment, but no plan to meet it, we can expect to be harshly assessed by countries that do have solid plans. This report shows that Canadian governments have done little to address climate change and the potentially disastrous consequences it could have on the economy and the health of Canadians. In fact, Canada's economy is structured to encourage ever-greater energy consumption, and therefore, ever-increasing greenhouse gas emissions. Government leaders have a duty to protect the health and well being of Canadians by designing a plan and taking action that will reduce emissions. *The Role of Government* shows how this can be accomplished.


TOYOTA

What stabilizing greenhouse gas emissions requires

The focus of this report is on energy-related emissions of greenhouse gases. Reducing these emissions must be at the core of Canada's strategy on climate change since about 85% of greenhouse gas emissions result from the production and consumption of energy.

About 85% of greenhouse gas emissions result from the production and consumption of energy.

Without government intervention, energy-related emissions in Canada grow at a rate of about 1.5% per year, or about 15% per decade.[1] These emissions are driven by increased fossil fuel production, increasing consumption per capita, and population growth. We can expect increases of this order to continue for the next decade, at least, unless governments act decisively.

Even if a target is reached in a specified year, population and economic growth will overwhelm policies that are just sufficient to achieve the target. For example, one commonly proposed mechanism for achieving greenhouse gas emission reductions is an emissions, or "carbon" tax. A tax sufficient to stabilize emissions at the 1990 level in 2005 would be insufficient to hold them at that level in 2010. Demographic and economic factors are likely to push emissions higher unless the tax were increased to take these factors into account. (The size of a carbon tax required to stabilize emissions is discussed in the Appendix).

Put simply, the environmental requirement is a finite ceiling on emissions, while the activities generating the emissions are expected to continue to grow. This tells us just how great the climate change challenge is. Chipping at the edges may achieve some short-term objectives, but will neither stabilize nor reduce emissions below 1990 levels over the longer term. Meeting this challenge means turning around a fossil fuel-based economy with considerable momentum behind it. This will require a number of consistent measures which alter the spending and investment choices of individuals and firms, and change technologies and infrastructure.

Although this may seem like an overwhelming task, it need not. Throughout human history, science and applications of new technology have revolutionized the way people live and the assumptions we make about our quality of life. Decades from now, the achievement of an economy with low greenhouse gas emissions may be seen by historians in the same way, for example, that we now see the principles of sanitation in modern cities. When central sewers, garbage collection and clean water distribution systems were being developed in 19th century France, a new class of government administrators drove the process, and property owners vehemently opposed them. This opposition was based on a belief that these systems would cost too much, infringe on individual rights, and slow economic growth. Yet who would argue against basic sanitation services today? And who would question the proposition that they have improved the quality of life?[2]

Answering the challenge means changing our energy policies now.

Finally, protecting the climate is often seen as only a long-term proposition, and therefore deferrable since the environmental effects will occur over decades. But achieving any target for reducing greenhouse gas emissions becomes harder with each passing day. Suburbs and roads expand, gasoline-powered cars are bought and high energy-use buildings are built. Answering the challenge means changing our energy policies now. Fortunately, changing energy policy to meet social objectives has a long tradition in Canada.

Energy policy: a history of change

The treatment of energy as a separate subject with its own institutions and policies has earlier origins in Canada than in many other countries.[3] Since the 1960s Canadian energy policy has reflected the overall objectives of government and the global circumstances of the day. As a result, our energy policies have changed several times over the years. At various times, government objectives have included creating jobs, keeping consumer prices down, securing tax revenue, avoiding trade imbalances, and reducing environmental impact. Global circumstances have included rapid changes in the price of crude oil, changes in energy production technology, varying estimates of remaining fossil fuel reserves, and concerns about air and water pollution. Over the last three decades, successive layers of special taxes, tax breaks, price regulations, and direct subsidies have been applied to energy producers and consumers, reflecting these shifting priorities and circumstances.

For example, in the late 1960s, Canadian oil producers received protected markets west of the Ottawa Valley, thereby keeping cheaper imported oil out. When, in 1973, the OPEC crisis caused the world oil price to skyrocket, Canadian consumers were sheltered from those price increases by the Oil Import Compensation Program. The National Energy Program (NEP) of 1980 was to have allowed the Canadian oil price to rise slowly, instead of jump to world levels. The NEP also contained programs to reduce Canadian oil dependence, which included subsidizing the natural gas, coal, and renewable energy sectors and promoting conservation. But then the world oil price collapsed, and the NEP with it. Since then oil prices in Canada have been unregulated. Natural gas markets were deregulated in 1985 following similar actions in the United States.

Now, Canada is a signatory to the Framework Convention on Climate Change (FCCC). Climate change could be the most challenging circumstance in energy policy history, because it requires an absolute global limit on the use of fossil fuels – below today's use – in a world where its use is increasing steadily. The circumstances and priorities are new, but the potential means to address them are not.

Climate change could be the most challenging circumstance in energy policy history, because it requires an absolute global limit on the use of fossil fuels.

Today's energy policy reflects mixed objectives

Today's energy policy is a patchwork of rules made for different reasons, at different times, and in different ways for different sectors. There is no pattern that would reflect a national policy objective of reducing greenhouse gas emissions, in the same way, for example, as the National Energy Program was designed to reduce foreign oil dependence.

Today, oil and natural gas producers, especially smaller ones, benefit from special income tax breaks which encourage the production of fossil fuels, and therefore greenhouse gas emissions. Only recently have more limited tax breaks been made available to suppliers of renewable energy. And the federal government has, in the past, poured billions of dollars directly into oil and gas megaprojects. But the effort to balance the federal budget has meant that direct subsidies to oil and gas producers have been cut. Federal and provincial governments also tax oil-based motor fuels substantially more than other consumer goods: about 50% of the pump price of gasoline is tax of one kind or another. (Canada's motor fuel taxes are higher than American ones, but lower than in the EU and Japan). Nuclear energy, which is a small source of greenhouse gas emissions, although not environmentally benign, continues to receive large infusions of federal money. Large hydroelectric projects, carried out by Crown Corporations, receive special borrowing guarantees and resource rights. Overall, the federal contributions to research and development budgets have been shrinking, but there is a slow shift towards energy efficiency and renewables.

The current pattern of taxes, subsidies, transfers and other financial elements of government policies in relation to energy, include:

- federal and provincial measures with respect to oil and natural gas production;

Today, oil and natural gas producers benefit from special income tax breaks which encourage the production of fossil fuels.

- federal and provincial excise taxes;
- municipal taxes on petroleum products;
- measures affecting supply substitutes, including renewables and nuclear energy;
- measures and regulations to increase energy efficiency; and
- regulated pricing of Crown and municipal electric utilities and gas pipeline and distribution companies.

Current energy policies both contribute to and undermine Canada's commitment to reduce greenhouse gas emissions. For example, the elimination of direct grants to fossil fuel megaprojects supports the commitment, as do various other measures, such as research budget shifts, the 1.5 cent increase in the gasoline excise tax in 1995, and the extension of certain tax breaks from oil and gas to renewables. However, recent expansion of fast-write-off eligibility for certain oil sands investments, near-elimination of electric utility demand-side management programs, and a slowing of progress in energy efficiency regulation counteract these.

Changes occurring since the Canadian government made a commitment to reduce greenhouse gas emissions, with a few exceptions such as a small federal Green Power Procurement program, do not constitute a strategic plan. The changes have been, for the most part, expressions of broader political objectives, such as deficit reduction, deregulation or regional job creation, or of local environmental policies, such as urban air quality. Of course, the purpose of a policy is irrelevant from an environmental perspective. Only its effect really matters. One must conclude that the combined effect of all measures and policies is inadequate since emissions in Canada have increased since 1990. Given the demographic and economic factors pushing emissions up, these policies will be inadequate for stabilizing emissions in the next century, let alone reducing them.

Inertia: barriers to reducing emissions

A successful greenhouse gas reduction strategy must overcome three sources of inertia: capital stock, bureaucracy, and technology. While these types of inertia exist in most economies, in Canada each has its own particular history.

Capital stock inertia

Buildings, vehicles, equipment, and infrastructure that use or produce energy are called capital stock, or just stock. Much of the capital stock tends to last a long time: power plants, buildings, transportation networks, and so on. Once built, it is relatively unlikely that long-lived stock will be torn down and replaced before its useful life is over. It is hard to imagine, for example, an energy price increase so large that it would cause an owner to tear down and replace an energy-inefficient building. Retrofitting would be the more probable method for reducing a building's energy use, even though retrofits are more expensive than designing efficient buildings in the first place.

Our current building stock was designed for a world without a climate change problem. Little can be done about the stock we have inherited, but every day new buildings, whose energy consumption is locked-in for the next 50-80 years, are being planned and built. If this stock is not designed with reduced energy use in mind, a major opportunity for long term, low cost emission reduction will have been foregone.

By definition, only a small percentage of long-lived stock of any type is replaced each year. This means that the immediate impact of a measure that affects only new buildings is relatively small. For example, even if the 2% of the stock that "turns over" each year is made 50% more efficient, the impact in the first year is only 1% of the total stock's energy consumption. There are therefore trade-offs between quick results and lasting results.

The biggest, longest-lived and most difficult stock to retrofit is a city itself.

The biggest, longest-lived and most difficult stock to retrofit is a city itself. Urban sprawl, single-use zoning and highway construction all create long-term greenhouse gas emissions arising from the travel requirements of a city's residents and commercial freight carriers. Urban planning literature is full of new ideas about how cities and towns could be more effectively designed to reduce energy use, and therefore emissions of greenhouse gases. Again, it is essential to design efficiently at the earliest stage.

Predicting the greenhouse gas reduction potential of urban design improvements is difficult. However, the benefits appear to be very large. For example, a French study suggests that reductions in fuel consumption possible from new urban policies would be equivalent to the imposition of a $280 tax per tonne of carbon emitted.[4] A tax this large would be equivalent to a doubling of the price of crude oil. The strength of urban redesign is that it reduces emissions at the core level of activity – less travel, less road-building, shorter water lines (less pumping and purification), and so on. It also produces economic conditions favouring the adoption of technologies that might otherwise be prohibitively expensive. District heating, for example, is less expensive when buildings mix commercial and residential use or where residential and commercial buildings are close to each other.

Many Canadian municipalities are members of the 20% Club, implying a commitment to reduce emissions by 20% by 2005. However most municipal councillors, including those in cities in the 20% Club, do not connect the climate change issue with urban planning. There are a few important exceptions, such as the City of Toronto, but at this time most municipal governments are unlikely to act to change urban form on the basis of the benefits associated with emissions reduction. At some point, revisions of municipal bylaws, land use designations and zoning may be understood as key success factors within a climate change strategy, even if those implementing the policy only understand it retroactively.

An effective climate change strategy must not overlook these opportunities. The sooner all levels of government are engaged in the challenge, the more effective and durable the strategy will be.

Bureaucratic inertia

Some of the major barriers to deployment of energy conservation in the 1970s arose from federal departments.

Inertia also exists in the form of bureaucracies. Just as consumers of energy are spread throughout the economy, government rules and programs related to energy use are spread throughout the government. For example, some of the major barriers to deployment of energy conservation in the 1970s arose from federal departments whose responsibilities covered the major energy-consuming sectors, such as the Department of Transport, the Department of Industry, Trade & Commerce and the Canada Mortgage and Housing Corporation.[5]

There has been an increase in cross-ministerial responsibilities and program coordination in national and provincial civil services since that time. However, energy policy is still not daily work for most departments. Only a Cabinet commitment to a binding target is likely to result in the kind of cross-departmental coordination needed for implementation. Cabinet(s) must make it clear that the commitment to reduce greenhouse gas emissions is not at issue. Otherwise the least-resistance path may involve denying the issue is pressing or insisting it can best be approached through the actions of another department.

For constitutional reasons, the control of greenhouse gas emissions in the energy sector is a federal-provincial matter in Canada. A binding commitment necessarily requires the Provinces to play a major role in implementation. The structure of any negotiations, responsibility allocations or offsetting financial considerations would be critical to the effective deployment of a national strategy. The concentrations of greenhouse gas emissions from Alberta and Ontario (roughly 30% each of total greenhouse gas emissions) suggest a prominent role for those provinces.

Technological inertia

The inertia related to technology involves more than the lives of individual devices that use energy. It encompasses linked systems of technologies and resources that are combined to provide energy services such as transportation, heat and light. For example, the automobile's internal combustion engine is part of a giant system stretching from oil fields to service stations. Similarly, an electrical grid is a system of power plants, transmission and distribution lines, together with, perhaps, rail lines leading from coal mines or pipelines from natural gas plants. These systems were built slowly over time. When any piece wears out, the default option is to replace it with something that "fits" on both ends, with whatever is already there. Even if a complete system redesign is truly the least-cost option, the decision cannot be made by individual investors whose decisions govern only a part of the system.

This effect can be a Catch-22. For example, the market penetration of compact fluorescent bulbs in North America has been hindered by the prior existence of lamps built for differently-shaped incandescent bulbs. Even though the incandescent bulb might wear out in 6 months, it cannot be replaced with a fluorescent because the lamp it would plug into is incompatible. The incandescent bulbs wear out quickly, but the lamps do not. Consequently, the fluorescent bulb can only replace the incandescent bulb when the lamp wears out. But suppliers that make lamps make them for incandescent bulbs, since there are so few fluorescent bulbs on the market, and the machines that make the lamps are expensive to re-tool and may "live" for many years.

If the world could be "re-invented" continuously, we would likely find that new, energy-conserving technology systems would be able to provide the same services at a lower cost. But, in reality, technological systems must fit the existing infrastructure and therefore compete with well-developed options already designed for it. In the above example, the combination of compact fluorescent-compatible lamps and compact fluorescent bulbs, in mass-production, could likely provide light at a lower total cost (including lamp, bulb and electricity) but breaking out of the Catch-22 is difficult.

Technological development tends to be strongly biased towards existing approaches to energy use. Technological "lock-out" can occur through the dominance of firms producing similar products, even if the industry as a whole is considered competitive. Industries that have a large market share in any particular technology can spend large quantities of research and development money to make small improvements to that technology, thereby protecting their market position.[6]

Technological inertia issues are very important for renewable energy supply, as well as energy efficiency. Practical renewable energy technologies already exist and most are economically viable in particular niche markets, such as photovoltaics in off-grid areas. But they are too expensive for broad market penetration today. Cost reductions come about largely through mass production of smaller units, rather than through single large units. Such technologies can make very rapid gains in the market, once they reach a critical threshold of acceptance. Mass production is made possible through increased market penetration, which is in turn made possible by price reductions based on mass production. This self-reinforcing cycle could lead to rapid growth, like VCRs and computers, once "lock-out" is no longer an issue.

Technological development tends to be strongly biased towards existing approaches to energy use.

Overcoming these three sources of inertia is a challenging task but not impossible if policy makers recognize and take them into account when designing greenhouse gas reduction policies.

Economic theory and emission reduction

Why would elected officials commit to reducing emissions and then not follow through? One reason is a concern that the economy would suffer. This is a legitimate concern, but it needs to be better defined in order to be addressed.

Indicators of economic success

Higher energy taxes offset by lower payroll taxes would reduce unemployment.

A commonly used indicator of economic success is Gross Domestic Product, or GDP. GDP measures the total monetary value of the goods and services an economy produces. The current debate about the economic effects of policies to reduce greenhouse gas emissions centres on how GDP could be affected. However, the "jobless recovery" illustrates that other important economic indicators, such as the employment rate, do not all grow in lock-step correspondence with GDP. Therefore, focusing on how policies affect GDP does not present a complete picture of the economic value of these policies. It would also be useful, for instance, to study the policies' effects on employment, the federal deficit, or the regional distribution of government revenue and spending.

For example, "mega" energy supply projects are among the very least labour-intensive in the economy, per dollar of investment.[7] Putting money into just about any other sector, including alternative energy or energy efficiency projects, would produce more direct jobs.[8] Similarly, a tax shift – higher energy taxes offset by lower payroll taxes – would reduce unemployment.

However, politics and economics do not always line up. In part, this is a consequence of the way government departments are organized. For example, they do not "trade" budget allocations based on job creation success. Perhaps more important is the fact that jobs in large-scale energy supply are concentrated, easily identified and have high local or regional impact, compared to the dispersed employment effects of spending or investment in other, more labour-intensive sectors. This bias is then reflected by the media. When a project is announced, no one sees the greater number of jobs that were foregone had the money been used elsewhere.

Furthermore, despite its widespread use, GDP is an imperfect measure of a nation's well-being. There are other widely-accepted indicators. One of them is the health of the environment.

Economic effects of controlling greenhouse gas emissions

Economic effects can be divided into three categories: (1) the damage from climate change itself (net of any positive effects), (2) the secondary effects of policies adopted to protect the climate – side benefits for the environment and human health apart from those gained by stabilizing the climate, and (3) the direct effects on income and expenditure in the market economy.

1. The costs of climate change

Another report in this series (Ellen Battle, Bill Stipdonk & David Suzuki's *A Glimpse of Canada's Future*) illustrates potential economic effects of changing climate. The Intergovernmental Panel on Climate Change (IPCC) estimates the annual costs of climate change could average 1-2% of GDP for developed countries.[9]

2. The side benefits

While an effective greenhouse gas emissions reduction plan would slow or reduce the damage from climate change, it would also have other positive economic effects from an improved environment and human health. For example, reduced fossil fuel use would cut illness and deaths caused by local air pollution, as well as crop damage from smog, and would lead to fewer oil spills due to lower tanker traffic.

Estimates of the value of side benefits vary dramatically, depending on assumptions about the economic value of environmental amenities and on how a greenhouse gas reduction policy is "credited" within initiatives that have multiple objectives, such as urban land use plans. For these and other reasons, all studies should be considered speculative. A survey by the IPCC concludes that, for the US and European countries, secondary benefits alone could offset between 30% and 100% of emission reduction costs.[10]

3. Direct effects on income and expenditures in the market economy

This is the main subject matter of the political debate because the costs are felt directly in the budgets of businesses and consumers. Analysing these costs and benefits is essential to making an informed decision about new policy directions. But this limited analysis would be valid only if emissions caused no economic damage. By analogy a cost-benefit analysis of central sewers over a century ago would not have taken into account the obvious public health and amenity benefits.

Some energy conservation and fuel-switching investments may yield economy-wide net benefits, even without considering economic benefits from an improved environment. Why might such activities not, in fact, be happening? Economy-

A survey by the IPCC concludes that, for the US and European countries, secondary benefits alone could offset between 30% and 100% of emission reduction costs.

wide benefits may not be being realized because real markets do not always work like the economically effective ones of theory. There are a variety of reasons: government regulations may prevent them from doing so; people might not have complete information; energy prices, and those of things that use energy, might not reflect economic costs; there may be split incentives and so on.[11] In this case, economic theory supports government intervention to correct market failure. This intervention is said to be "worth doing anyway" – even if there were no environmental problems.

An energy policy that neither helps nor hinders anyone accomplishes little.

How much is worth doing anyway? Different types of analysis say different things, mostly due to underlying assumptions. Top down analysis looks at the economy in terms of broad economic aggregates, uses relatively abstract representations of technology, or represents only ideal economies to start with. Bottom up analysis looks at the costs and benefits of specific choices by households and businesses and adds up their emission consequences. Top down models tend to find relatively little worth doing anyway. In some cases, the mathematical structure precludes it. In contrast, most bottom up models find an abundance of economic greenhouse gas reduction opportunities that are not being done. A survey of studies for Canada and other industrial countries shows a spread in bottom-up estimates with many of the results showing economic levels of emissions at 10-30% below the 1990 level.[12]

Economists continue to debate over the extent to which the gap between theory and observed behaviour reflects market failure (which warrants government intervention) or simply exclusion of economically "valid" costs from the analysis (which argues against government intervention). The answer is probably somewhere in the middle. Not all the apparent opportunities "worth doing anyway" are truly there. Sometimes there are hidden economic costs, such as risks of new technologies, operational disadvantages or the cost of buying or selling itself. But sometimes government plans or rules create hidden costs in the first place, meaning a change in plans or rules would be economically beneficial in any case.[13] There are also more subtle reasons for the gap, relating to the way energy is perceived (or not understood). There are, for example, well-documented cases where a more energy-efficient product is readily available to consumers, provides identical value to the standard product, has a much higher rate of return, results in no increased risk and causes no known extra costs or side-effects, but is not purchased.[14]

A balanced approach to exploring what is worth doing anyway would look specifically at different sectors and applications. From an economic theory standpoint, not all energy-related greenhouse gas reduction policy is worth doing anyway, but a significant portion appears to be economically worth doing, even in a world without a greenhouse gas problem.

Policy: from theory to practice

There are parallel tracks, analysis and implementation, within a greenhouse gas emission reduction strategic plan. Analysis involves anticipating the likely effects of various measures. Implementation means determining how a measure will be deployed. An effective plan intertwines these tracks, adjusting both analysis and implementation as results become apparent. The following applies to governments at all levels.

Analysis

Most of the analytical work in Canada has focused on studies of the monetary costs and benefits of greenhouse gas emission reduction measures. These are only the beginnings of a strategic plan. They focus on whether emission reduction measures have positive or negative effects on the economy as a whole, with a positive effect being in the public interest. However, as explained in the previous section, before a government makes a commitment to meeting a target, it must take all the relevant economic and non-economic factors into account. Once government has made a decision, the analysis must guide policymakers to *meet* the objective, not on *whether to* meet it. The scope must therefore be expanded to include all the factors that influence success, defined in terms of meeting the target. Unfortunately, most of these factors are not considered within economic models.

Market-based instruments tend to work as well as direct regulation and at lower cost.

The scope of a market plan would likely include, for example:

- emphasis on short-term distributional effects, among provinces and sectors, between producers and consumers, between rural and urban residents and among different household income levels, rather than economy-wide impacts;
- preparation of, support for, and follow-up on intergovernmental negotiations, in which offsetting compensation could range over the entire spectrum of transfers and taxation, not simply within the energy or other sectors which affect the levels of greenhouse gas emissions;
- strategies to compensate classes of householders and businesses which are adversely affected by new policies;
- review and analysis of legislation and regulations, especially municipal bylaws;
- development of economic incentives;
- review and analysis of planning guidelines and assumptions for government infrastructure, such as highways, ports, airports, bridges, water and sewage systems;
- targeted and general education about energy efficiency and greenhouse gas reduction measures;

- development of administrative systems and financing procedures;
- analysis of the needs and perspectives of the many interests and commercial concerns potentially affected by sector-specific measures.

Implementation

Canadian governments have approached the task of greenhouse gas emission reduction relying exclusively on voluntary measures. But voluntarism is not enough. Governments have to make rules and enforce them. An energy policy that neither helps nor hinders anyone accomplishes little.

Alternatives to voluntarism include market-based instruments and direct emission regulation. Direct regulation imposes legal obligations to reduce emissions on specific emitters. It is effective if enforced but may stifle innovation and block economic opportunities.

Market-based instruments are indirect. They rely on changing the costs or convenience of economic activities. These instruments are, in principle, not only less intrusive, but if well-designed, tend to work as well as direct regulation and at lower cost. They include taxes, subsidies, price regulation, design incentives, and tradeable emission permits.

In a tradeable permit system, a fixed number of emission permits (the right to emit a specified amount of greenhouse gases) are issued by the government and can be used, traded and perhaps saved for a limited time. A tradeable permit system is especially appealing because it can be designed to guarantee the environmental objective – emissions are capped at the level indicated by the total number of permits issued – while the permit holders meet the targets in ways which are best for them.

Permit trading has been applied successfully to sulphur emissions from US coal-fired power plants and to lead in gasoline. It has, however, never been applied on the scale that would be required for greenhouse gas emission control.

Other market-based instruments tend to be specific to a particular sector, type of fuel, or type of energy use. Sector-specific instruments tend to act indirectly, for example by improving financing terms for energy-efficient equipment, by diverting money from road-widening for cars to transit infrastructure, by influencing distribution channels for certain types of equipment, or by supporting research and development initiatives.

The Forecast Working Group of the (Canadian) National Air Issues Coordinating Mechanism considered approximately 60 specific measures relating to energy consumption.[15] Typical measures considered by the Forecast Working Group include:

- More and better energy efficiency regulation within building codes;
- Gas guzzler taxes, or “fee-bate” systems, where purchasers of inefficient cars are taxed and purchasers of efficient cars are rebated with the money so raised;

- Mortgage interest rate discounts for energy-efficient buildings;
- Revision of municipal bylaws to remove barriers to healthy building design;
- Utility connection fees;
- Removal of financing and administrative barriers for efficient district energy systems and small-scale power generation;
- "Golden carrot" programs for appliance and equipment efficiency. These are contests where, for example, a cash prize or access to distribution channels is awarded to the designer of the most efficient appliance;
- Low-interest loans for conservation retrofits
- Incentives to shift modes of travel, such as making employee parking a taxable benefit and building bicycle paths;
- Municipal incentives to increase density, such as density bonuses and development cost charge incentives and disincentives;
- User-pay road pricing;

and many others.

For consumers, energy prices are rarely the sole, or even principal reason for decisions affecting energy consumption.

What general approach works best?

The answer to this question depends on the market in question. As noted earlier, in Canada 85% of the greenhouse gas emissions result from the production and consumption of energy. Of these emissions, approximately 40% come from the production of fossil fuels and of electricity. Large industrial consumers of energy produce approximately 15% of Canada's energy-related emissions. An emission tax or a well-designed tradeable permit system is likely to be the most cost-effective way to get results from fossil fuel producers, power generators and at least some large industrial energy users. These approaches work by causing emissions to have a direct financial cost. If bulk commodity producers are operating competitively, they respond directly to costs and prices and only to costs and prices. Their emissions result from carefully-analysed investment decisions and they have the expertise to make informed trade-offs. The extent of industry adjustment would be determined by the severity of a tax or, under emission trading, the emissions cap.

The remaining 45% of energy-related emissions come from consumption of fossil fuels by households, light industry and the commercial and government sectors. In these sectors, economic agents use, and perceive their use of energy, in very different ways. For these reasons, an emission tax or a tradeable permit system is likely to be relatively less effective.

In light industry and services, energy is a small, often negligible component of costs. Consumer product and service providers tend to be concerned with differentiating themselves from competitors, rather than with simply minimizing bulk commodity costs.

Small business and consumer markets are also less responsive to the economic signals given out by direct emission pricing because of the rigidity and complexity of the arrangements under which their emitting activities are governed:

> "Builders, code officials, heating contractors, automobile dealers, utility company representatives, architects, appliance salesmen, and so on operate through elabourate networks of commercial and governmental relations that mediate and structure the relations between consumer and manufacturer .... [I]ntermediaries' incentives to pursue energy efficiency are few, while their disincentives are many. Market intermediaries are often motivated by problem avoidance and risk aversion, and are influenced by the competitive, contractual and regulatory environments within which they operate. Government intermediaries frequently adopt regulations and promote development projects that are politically, rather than technically motivated, and are therefore indifferent to energy impacts."[16]

Taxes or tradeable permits are efficient where decisions affecting emissions are made solely on the basis of costs and prices.

Psychological research on energy consumption also supports the idea that consumers tend to respond less to price than may be commonly assumed. People do not think of energy consumption as an activity they intentionally do, but as a side-effect of other activities.

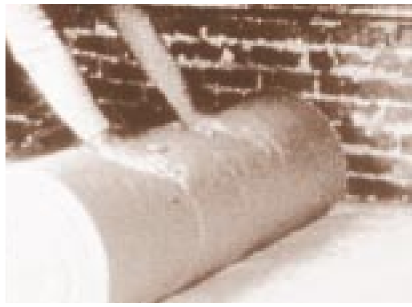
Studies show that energy prices are rarely the sole, or even principal reason for decisions affecting energy consumption.

> "By assuming human behaviour to be a relatively insignificant aspect of consumption, these [Physical-Technical-Economic] models overlook the central role of human action in shaping energy use .... The research ... suggests that policy analysis based on [these models] ... exaggerates the importance of energy prices and technological solutions, while underestimating the importance of social action and non-economic influences."[17]

Consider, for example, wall insulation in houses: most people require apparently unreasonably high rates of return on its installation. Because tenants pay utility bills, landlords have little reason to insulate their rental properties. Tenants may not either because they are likely to move and therefore would not receive the long-term financial benefits of insulation. Well-insulated houses sell better on their qualities of quietness, comfort and "high-end" construction than on energy savings. Builders in hot markets have been known to remove insulation immediately after inspection, for later use in the next house. And people want double windows, the most expensive but most visible standard household efficiency measure, before they want to seal cracks and insulate, the most cost-effective but least visible measures.

Saying that consumers are price-insensitive is equivalent to saying that a tax high enough to stabilize consumption-related emissions, all by itself, would have to cause price increases that are high by historic standards. The Appendix describes research in support of this conclusion.

Therefore it appears that a mixed strategy is likely to be the most successful. Taxes or tradeable permits are efficient where decisions affecting emissions are made solely on the basis of costs and prices. Sector-specific reduction measures should be adopted for consumers whose decisions are less dependent on energy prices. Fuel and electricity producers and at least some large industry would be in the former category. Small-to-medium energy consumers which includes light manufacturing, commercial and government services, and households would be in the latter.



There is no "magic bullet" to design the perfect mix of measures.

The difference between emission pricing (direct measures) and indirect measures does not have to be one of financial impact. For example, emission tax revenues, or revenues from a tradeable permit auction can be returned to those taxed in the form of benefits that still allow net emissions to decrease, while indirect measures can be "sticks" or "carrots."

There is no "magic bullet" to design the perfect mix of measures. A strategic plan will have to find specific ways to overcome inertia, which is different in each sector. It is beyond the scope of this paper to outline sector-by-sector strategies. However, practical knowledge derived from 20 years of marketing energy conservation is a good starting point. Conservation has been marketed through utility demand-side management programs, through government programs of the 1980s, and through the varied successes of municipal initiatives to create sustainable cities. These programs improved greatly when engineers and economists learned to take people and the commercial and social systems within which they operate, not just prices and technology, into account.

> "US Energy policies have often foundered in problems of implementation ... [I]ncentives designed to motivate economically rational decision makers often fail with ordinary citizens; and many people disregard even the best technical information. Policies based on careful technical and economic analysis have often been psychologically naive or politically unrealistic. The reason lies in oversimplified ... analysis ... that has serious blind spots in the area of human behaviour."[18]

Among related discoveries:

- The success of a specific measure tends to be governed as much by its means of implementation, compatibility with existing commercial and administrative arrangements and public perception of the philosophy it is predicated on, as by the estimated financial effects on parties involved.

- The marketing of energy efficiency has much in common with the marketing of anything else. Consumers do not generate demand independent of what producers have to sell or how they advertise.

> "Producers and consumers share in the continuous expansion of consumption in contemporary society – an expansion that is linked to the continuous growth of energy demand and with its array of negative environmental impacts. Study of these complex interactions requires a sorting out of the processes by which consumers and producers influence one another – e.g. through demands for energy-rich goods and services, through the control of goods offered in the market, and through the use of advertising, pricing, and the continuous re-invention of style to induce purchase. To date, our understanding of consumer-producer relations has been limited by the widely-held notion that producers only strive to satisfy consumer demands over which they have little control – a partial view at best ... Energy and behaviour research ... clearly indicates, for example, the weakness of models centred on individual choice and action, and it cautions against over-reliance on rationalistic expectations."[19]

To effectively reduce emissions, the governments of Canada must have a plan.

- Providing market incentives to manufacturers and distributors is more successful than providing either incentives to consumers or disincentives to anyone.
- Programs to change purchasing behaviour at the point of sale have high administrative costs and low market penetration. Changing design at the point of manufacture is far more effective.
- Measures that "do things to things" have lasting effects. Measures that "do things to people" do not, unless continually reinforced. After the 1973-83 oil crisis, for example, conservation savings that resulted from new technologies and investment in energy efficiency persisted while behaviour, such as thermostat set-back, showed substantial reversals.
- A design process that makes energy efficiency a basic objective often results in capital cost savings or service quality improvements that are greater than the energy cost savings themselves.
- People and firms generally "satisfice" – accept solutions that are second-best because they work acceptably well and nobody can be rethinking everything all the time. Energy efficiency is most effectively delivered as a component of a package, and delivered at a time when other decisions are being made. For example, purchasing a low-flow shower head might be an investment with a 50% rate of return, but it is far more likely to happen when there is a renovation going on anyway.

Conclusion

Canada is not meeting its commitment to reduce greenhouse gas emissions because it has not taken it seriously. There is little knowledge among politicians of the range of options for meeting a commitment, and their benefits, costs, distributional consequences and strategic advantages and disadvantages. Current discussion focuses on only a narrow portion of the required analysis. Many benefits to emission reduction are not visible within that framework.

To effectively reduce emissions, the governments of Canada must have a plan. Reducing fuel consumption, shifting to less emissive fossil fuels and reducing emissions from energy production are key to any plan, because these sources represent 85% of Canada's emissions.

Voluntarism will not do the job. Special efforts are required to overcome resistance to change. Sources of inertia include the long economic lives of capital stock, technology barriers and bureaucratic issues specific to energy consumption.

Lessons learned from energy efficiency programs, utility demand-side management and research into how people and firms incorporate energy within their decision-making must all be applied. Economic instruments that directly act to change fuel prices, such as taxes or tradeable emission permits, are expected to work better for energy producers and at least some large, bulk commodity producers. Energy consumption in smaller firms, government operations and households is not governed to nearly the same extent by price. In these sectors, a mix of measures, both price-based and sector-specific, make sense. Among all levels of government, the municipal level holds the key to long-term greenhouse gas emission reduction, through its governance of infrastructure, land use, and building and community design.

Energy Taxes and Consumption-Related Emissions

Consumption tax increases may be visible because we are all consumers. But how much would an increase in consumers' energy prices reduce demand for energy or encourage fuel-switching to lower greenhouse gas supply?

First, we look at "back-of-envelope" numbers that support more sophisticated analysis reported below. Economic estimates of consumer response to energy price changes vary widely, depending on model, data and assumptions. A typical estimated value of the demand elasticity is -0.4, that is, a 10% price change induces a 4% consumption change in the opposite direction. To illustrate what this would mean, assume emissions would grow at 1.5% per year in the absence of government action. If the government decided to maintain greenhouse gas emissions in the year 2010 at the level they were in 2000 a continuous fuel price increase on the order of 3.75% per year, above inflation, would be required. To get down to 1990 emission levels, which are predicted to be 92.5% of 2000 levels, the price of energy would have to grow at even a higher rate.

However, this analysis is not complete because models that estimate consumer response to price changes statistically remove the effects of economic growth on demand. In fact, the economy is growing at about 2% per year. This growth is driven about 50% by population growth and about 50% by increases in output per capita. The factors affecting per capita output include increases in driving distances and number of cars per capita, higher sales of electronic devices per home, more commercial floor space per capita and higher penetration of air conditioning, all of which have caused increased energy consumption in recent times.[20]

How high would a price increase have to be to neutralize the effect of economic growth on emissions? If GDP grows, on average, between 1990 and 2005, at 2% per year, then total greenhouse gas emissions per dollar of GDP

The Gasoline Excise Tax: Deficit-Fighter or Greenhouse Gas Tax?

Energy prices affect consumption. Raising them will, all other things being equal, reduce consumption and therefore, emissions.

Almost by definition, consumer taxes are visible to more people than are producer taxes. This makes the political feasibility of raising them difficult, except when other circumstances allow such an increase with little change in the final price.

Gasoline is the classic case. Roughly half the pump price of gasoline is tax, including provincial and federal consumption taxes. The federal gasoline excise tax now constitutes about 18% of the pump price of gasoline. Between its inception in 1975 and 1995, the tax increased at an average rate of 2%

CONTINUED NEXT PAGE >>

will have to fall by 26%, relative to 1990, in order to stabilize emissions in 2005 at 1990 levels. In fact, between 1990 and 1995, energy-consumption-related greenhouse gas emissions per dollar of GDP did not change.[21] To stabilize emissions at the 1990 levels this would mean that emissions per dollar of GDP would have to fall by 26%, or 3% per year between 1995 and 2005.[22]

This kind of drop in emissions per dollar of GDP has occurred before. During the period of greatest consumer energy price increases in modern Canadian history, 1979 to 1984, annual emissions per dollar of GDP decreased by 3.3% per year. This drop was primarily due to the dramatic increases in energy prices – during this time period, the all-energy price to consumers rose each year by an average of 6.3% faster than inflation. At the same time there were a number of conservation and oil-to-gas conversion programs under the National Energy Program, which contributed to the historic decrease in emissions per dollar of GDP. Therefore, it follows that the same price increase acting alone would have been insufficient to achieve the same decrease in emissions. A 6.3% real per annum price increase, if applied to gasoline, would raise prices from today's Canada-wide average of about 57 cents/litre, to 93 cents/litre in 2005, expressed in 1997 dollars. This might be achieved by raising the tax on gasoline by 4.5 cents/litre each year starting immediately.

This simplistic back-of-enveloping suggests that, in the face of steadily increasing economic activity, substantial increases in consumer energy price would be required to induce emission stabilization, if it were the sole policy instrument. And, of course, if stabilization is inadequate to address the potential climate change problem, then even more severe increases in prices would be required.

Of course, the actual economy is not described by a single GDP number, nor can price effects be captured in a simple number. The economy is made up of thousands of separate activities. Energy use varies widely across sectors and among consumers of energy. Price effects occur in complex ways, differently for different energy forms in different uses and regions, differently over time and depending on how quickly a given price changes.

Economic models attempt to take such effects into account. They can be used to estimate the price increases that might be required to stabilize emissions in the face of continued economic and population growth. Results tend to vary widely, and no single model's results should be considered as an accurate prediction. However, by considering many models, of different types and in relation to other research, one can draw general conclusions.

Top-down models

The Energy Modeling Forum (EMF) of Stanford University compared the results of 14 models for the United States, in a comprehensive exercise based on common assumptions.[23] The model results varied widely, as expected, and the

>>CONTINUED FROM PREVIOUS PAGE

above inflation, with roughly three quarters of the increase (or 6.5 cents/litre) occurring since 1985. The period since 1985 has been one of energy self-sufficiency and stable or falling crude oil prices, which removes the purely economic reasons for price increases warranted by the oil crisis of the previous decade. It appears that the gasoline excise tax is primarily a general taxation measure – a deficit fighter. The key consideration appears to be the change over time of the pump price of gasoline, not economic or environmental policy.

When oil prices fall, the opportunity exists for a tax increase with no adverse effect on the pump price, compared to the previous year but not compared to what the pump price would have been in the absence of the increase. If this is true, increasing the tax depends on the existence of lower gasoline production costs, for little ultimate consumer effect. The environmental issue remains unaddressed.

reasons have been carefully analysed. The range of estimated carbon taxes necessary to stabilize US emissions at 1990 levels by the year 2010 ranged from $20US/tonne carbon to $150/tonne carbon. The average tax estimate was $74/tonne for stabilization by the year 2010; the corresponding estimated tax for achieving stabilization in year 2005 was approximately $80US/tonne.

These models used common assumptions about GDP and population growth, availability of fossil fuels and long-term energy supply possibilities. Base case GDP and greenhouse gas emissions were assumed to grow at 2.2 and 1.0 percent per year, respectively.

A tax of $80US/tonne carbon amounts to $105Cdn/tonne carbon, or roughly 7.5 cents/litre of gasoline and $1.60/GJ of natural gas – about 15% of gasoline prices and 30-55% of end-user natural gas prices. The taxes were assumed to apply at the beginning of the period in the EMF modeling. Given that no significant taxes have been applied seven years after that time in Canada, the estimated minimum tax required to reach a comparable emission level would be substantially higher if initiated today.

The results also suggest, consistent with theory, that a greater-than-stabilization requirement for emission reduction induces more-than-proportional increases in the size of the carbon tax required to achieve it. For example, the average result among the models of the tax required to achieve a 20% emission reduction below 1990 levels in the US in 2010 was $182/tonne carbon, with results ranging from $50 to $330.

Because of the similarities between the US and Canadian economies, one would expect that a tax of similar magnitude to the EMF estimates would be required to stabilize Canadian greenhouse gas emissions. For example, a recent study estimated the magnitude of a phased-in (revenue-neutral) carbon tax that would stabilize Canadian greenhouse gas emissions at 1990 levels by the year 2000.[24] The Canadian tax is assumed to be phased in over the three years from 1994 to 1996. In 1994, the tax would be $40/tonne carbon; 1995: $75/tonne; 1996 and thereafter: $150/tonne. It is difficult to compare the differences between tax levels, phase-ins and start dates, but this result appears roughly compatible with the EMF average.

The $150/tonne carbon tax estimate for Canada translates into a $2.30/GJ tax on natural gas. This is roughly equal to average end-user price increases of 30% (residential) 40% (commercial) and 80% (industrial) if passed through on an equal per-GJ basis. The $150/tonne carbon tax also translates into an $18.40/barrel tax on oil which is approximately equivalent to an 11-cent-per-litre gasoline tax and a $106.54/tonne tax on thermal coal. This represents a 10-fold increase in the Alberta coal price and a doubling of fuel prices for Ontario's coal-fired power plants. This tax estimate is based on the assumption that GDP and greenhouse gas emissions grow at 2.8% and 1.2% per year, respectively, from 1990 to 2000, and 2.5% and 1.3% per year from 2000 to 2010, in the no-tax case.

These results should be taken as illustrative and approximate. Various secondary effects would reduce the price shock and are reflected in different ways in different models. For example, a high tax would reduce fossil fuel production levels if applied internationally. This would depress after-tax prices that producers receive. The reduction in producer prices would then flow through to consumers and stimulate demand. However, the evidence is that the tax required to achieve the targets being considered is of the order of magnitude suggested above, if tax is the sole instrument used.

Decomposition analysis

Decomposition analysis is a means of organizing data so as to be able to distinguish between emission changes due to changes in levels of economic activity versus how much energy was used for each unit of activity. Decomposition analysis of price, activity and efficiency changes for each sector over recent historic periods provides important guidelines for the development of future greenhouse gas reduction strategies. Detailed breakdowns are available, and provide interesting lessons for each sector. The primary conclusion is that energy consumption changes have been driven largely by factors other than energy prices, such as demographic trends, changes in industrial production technologies and land-use planning.

At the most aggregate level, energy use in Canada increased by about 13.6% from 1973 to 1987.[25] The increase occurred despite an increase of 45% in the real (after-inflation) energy consumer price index. Energy use increased in each sector over this period, but by differing amounts. Residential use increased by 3%; commercial by 22%, industrial by 18% and transportation by 11%. The increases in real energy prices were: 51% in the residential sector, 43% in the commercial sector, 46% in the industrial sector and 28% in the transportation sector.[26] Increases in energy use over this period were most likely lower than they would have been in the absence of the price increases, and in fact energy intensity (energy use per dollar of GDP) declined in each of the four sectors: by 36% in the residential sector, by 24% in the commercial sector, by 26% in the industrial sector and by 31% in the transportation sector.

This type of historic evidence, which is not really modelling, but simply arrangement of data, suggests that economic growth has in the past caused energy consumption to rise, even in the face of substantial energy price increases and government conservation programs, such as those of the National Energy Program. While energy use declined substantially in relation to GDP the net effect was still an increase in absolute terms, due to increased economic activity.

Bottom-up models

Bottom-up or end-use based models simulate the technological options and prices available to consumers. For a given set of prices, it selects the option of least total cost to the economy (energy plus equipment and labour) and estimates the emissions arising from choosing that option. However, just because a model says an option is of least total cost does not mean the market will do it. Model results suggest that, generally, emissions associated with least-total-cost options are less than actual emissions.[27] The difference between actual emissions and emissions related to least-total-cost options represents the economic potential for emission reduction. Typical results suggest economic emission reduction potential on the order of 20-40% of actual emissions, relative to a baseline forecast.[28] These estimates do not take damage costs of emissions into account. Results also suggest that the emissions associated with investments of least total cost are more sensitive to changes in energy prices than what is observed in the market. In other words, the theory says that price increases should induce greater emission reductions than market experience suggests would actually happen.

The evidence, from all three types of analysis, therefore supports the proposition that fuel price increases, if used as the sole measure to achieve emission stabilization, would have to be high by historic standards to be effective.

NOTES

1. See for example, Natural Resources Canada. April 1997. *Canada's Energy Outlook 1996-2020*. Charts 7.8 and 7.9.
2. *Voltaire's Bastards*; John Ralston Saul; Penguin Books, 1993, pp. 238-240.

   "Put in contemporary terms, the market economy angrily and persistently opposed clean public water, sanitation and garbage collection and improved public health because they appeared to be unprofitable enterprises which, in addition, put limits on the individual's freedom."
3. Helliwell, John F. 1979. "Canadian Energy Policy" in *Annual Review of Energy*. Vol. 4, p. 175.
4. Hourcade, J.C., N.B. Chaabane, K. Helioui, V. Journe and P. Maibre. 1993. *UNEP GHG Abatement Costing Studies: France Country Study*; Centre International de Recherche sur l'Environnement et le Developpement (CIRED). Montrouge, France.
5. Brooks, David. 1981. *Zero Energy Growth for Canada*; McLelland & Stewart Ltd.; p. 206.
6. The automobile might be a good example. There is a compelling argument that improvements in automobile efficiency have been relatively costly, incremental changes to an obsolete design.

   "... until about 1993, the conventional wisdom framing the US car efficiency debate was that the doubling of new-car efficiency during 1973-86 had virtually depleted the 'low-hanging fruit' – opportunities for fuel economy consistent with affordability, safety and performance. Further improvements are widely assumed to be small, incremental, difficult, expensive and likely to worsen air pollution ... The short-term approach universally adopted in US officialdom's pre-1993 car-efficiency debate is valuable for understanding the potential and limitations of *incremental* improvements to stamped-steel, direct-mechanical-drive, internal combustion, gasoline – or diesel-fueled cars; but it says nothing whatever about what completely *different* designs can do." [emphases in original]

   – Lovins, Amory B.; 1995; *Supercars: Advanced Ultralight Hybrid Vehicles*. National Conference on Sustainable Transportation. Oct. 30-Nov. 1, 1995. Simon Fraser University, Vancouver, BC.

   Complete changes in automobile design may not be being implemented, in part because of lock-out effects, even if the redesigned automobiles would be less expensive in total and could therefore, presumably seize greater market share. Narrow incrementalism in the design of more efficient cars dominates the industry, despite the possibility that it may be more difficult to increase automobile efficiency by small amounts than it would be to increase it by a factor of five through basic redesign, even using today's technologies.
7. See, for example, the literature survey by Marbek Ltd. and G. E. Bridges & Associates in *Energy Investments and Employment*, for B.C. Energy Council, 1992.
8. Campbell, Barbara, Larry Dufay and Rob MacIntosh. 1997. *Comparative Analysis of Employment from Air Emission Reduction Measures*. Pembina Institute report prepared for Environment Canada.
9. Intergovernmental Panel for Climate Change. 1995. *Economic and Social Dimensions of Climate Change: Contribution of Working Group III to IPCC's Second Assessment Report*; J. Bruce, P.H. Lee and E. Haites (eds.). Cambridge University Press, Cambridge, U.K., p. 183.

10. *ibid*. p. 218.
11. A split incentive occurs when the energy bill-payer cannot reasonably be the investor in efficiency. For example, neither building owners nor utility bill-paying tenants (who may move soon) have a reason to install cost-effective insulation.
12. *Canadian Options for Greenhouse Gas Emission Reduction*; Final report to the Canadian Global Change Program and the Canadian Climate Program Board; Royal Society of Canada; Technical Report Series 93-1; September 1993 p. 9 para. 3; sentence 2.
13. See for example, *Regulatory Barriers to Healthy Housing in Canada*, Canadian Mortgage and Housing Corporation 1997 or *A Tool Kit for Community Energy Planning in BC*; for the BC Energy Aware Committee (c/o Odette Brassard, Union of BC Municipalities).
14. See for example, Levine, M.D., J. Koomey, J.E. McMahon and A.H. Stanstad (Energy Analysis Program, Lawrence Berkeley Laboratory, Berkeley, California), and Eric Hirst (Oak Ridge National Laboratory, Oak Ridge, Tennessee). 1995. *Energy Efficiency and Market Failures.*
15. *Microeconomic and Environmental Assessment of Climate Change Measures*; Forecast Working Group; National Air Issues Coordinating Mechanism; April 1995.
16. Lutzenhiser, Loren. 1993. "Social and Behavioral Aspects of Energy Use"; *Annual Review of Energy*; Vol. 18, p. 276.
17. Stern, Paul. 1992. "What Psychology Knows About Energy Conservation" in *American Psychologist*, Vol. 47. No. 10; October.
18. Lutzenhiser, Loren. 1993. "Social and Behavioral Aspects of Energy Use"; *Annual Review of Energy*; Vol. 18, p. 276.
19. *ibid.*, p. 277.
20. Natural Resources Canada. April 1996. Energy Efficiency Trends in Canada, Report for the period 1984-1994.
21. NAPCC Review data, combining all GHG emissions in CO_2-equivalence, except for electricity generation, petroleum industry and non-energy emissions. The ratio actually fell by .08% per year.
22. Of course an overall stabilization objective can be achieved with greater-than-stabilization in non-energy-related activities and less-than-stabilization in energy, and even by investments outside of Canada. This example implicitly assumes energy consumption is "responsible for" its pro-rata share of the reduction needed to stabilize, just for illustration.

    If emissions per GDP do not change between 1995 and 1997, the rate of decrease in emissions per GDP would have to go up to 4% per year from 1997 to 2005.
23. For a description of the EMF exercise and results, see *Climate Change 1995 – Economic and Social Dimensions of Climate Change*; James Bruce, H. Lee and E. Haites, Eds. Cambridge University Press, 1995 Chapter 9: pp. 304-308. Also, *Reducing global carbon emissions – Costs and policy options*. EMF (Energy Modeling Forum), 1993. EMF-12. Stanford, CA: Stanford University.
24. DRI Canada and Marbek Resource *Consultants, Canadian Competitiveness and the Control of Greenhouse Gas Emissions Through Imposition of a Carbon Tax*. Lexington, MA: DRI/McGraw-Hill. June 1993.
25. This includes the period 1973-84, during which time prices rose, and 1984-87, when they fell.

26. Blended real energy prices in the residential, commercial and industrial sectors and gasoline prices in the transportation sector (source: *Energy Demand in Canada, 1973-1987: A Retrospective Analysis*; Marbek Resource Consultants, in association with Torrie Smith Associates, Diener and Associates and Statistics Canada, 1989).
27. This would be the difference between "economic" and "natural" run results. There are many such studies. See for example, Jaccard, Mark, Alison Bailie and John Nyboer. 1996. "CO_2 Emission Reduction Costs in the Residential Sector: Behavioral Parameters in a Bottom-Up Simulation Model" in *The Energy Journal*, Vol. 17, No. 4, pp. 107-133.

    It is not always the case that emissions from least-total-cost investments are lower. For example, coal may be less expensive for industrial boilers than gas, but the industry may prefer gas for its ease of handling and compliance with local air regulations. These cases are exceptions that tend to prove the rule.
28. See, for example, Table A-2, Appendix of the "COGGER" report (note 12).

CLIMATE OF CHANGE:
THE DAVID SUZUKI FOUNDATION'S NEW REPORT SERIES

A Glimpse of Canada's Future

Written by Ellen Battle and Bill Stipdonk of Metrix Consulting and by Dr. David Suzuki, this report examines the ways Canada could be affected by climate change. Some of the topics covered include: how the greenhouse effect works, and how a warmer world will affect the social, economic and environmental fabric of Canada.

Canada's Window of Opportunity

This report examines how a lowering of greenhouse gases would affect Canada's social, economic, and environmental goals. Specifically, the authors outline the benefits of switching to cleaner, less harmful energy sources. Suggestions for strategies which would help Canada make the transition to a sustainable future are also included. Authored by Ralph Torrie and Dr. Amory Lovins, this report provides readers with a snapshot of how Canada might prosper in a low-carbon future.

Taking Charge: Personal Initiatives

Written by Pembina Institute climate change director Robert Hornung, this report shows how the actions of individuals and communities can affect climate change. Examining everything from personal purchasing habits, daily behaviour, and lifestyle choices, to official community plans and growth strategies (development permits, zoning bylaws, etc.), the authors show how local actions can significantly cut Canada's rate of greenhouse gas emission.

Keeping Canada Competitive

Since the 1992 Rio Earth Summit, few countries have lived up to the agreed goal of stabilizing greenhouse gas emissions at 1990 levels. Here in Canada, it is estimated that emissions are already between 8 and 13% above 1990 levels – one of the worst records of any developed nation. Canada's former chief negotiator Doug Russell, (with contributions from Pembina Institute's Robert Hornung) review how Canada's performance has compared with other countries, and examine the implications of Canada's failure to keep pace with international efforts to reduce greenhouse gas emissions.

Taking our Breath Away

The Health Effects of Air Pollution and Climate Change

This report explores the link between fossil fuel combustion, climate change, air pollution and human health. The authors, two medical epidemiologists and an air pollution specialist, find that as many as 16,000 Canadians are already dying prematurely every year as a result of air pollution. And because heat and sunlight are critical factors in the production of smog, global warming is expected to make air pollution worse. The authors conclude that climate change and air pollution are likely to further erode human health unless immediate steps are taken to reduce world consumption.

Canadian Solutions

In the final report of the series, we will analyse the commitments Canada made in Kyoto in 1997 at the Conference of Parties and propose an action plan to fulfill those commitments. Written by the David Suzuki Foundation and the Pembina Institute, this report proposes policies for Canada's municipal, provincial, and federal levels of government.

This report is printed on **Arbokem**, which is 45% agri-pulp, 43% post-consumer waste paper, and 12% calcium carbonate filler. Arbokem is manufactured by a totally chlorine and effluent free agri-pulp process.

Design: Alaris Design
Printing: Western Printers

Finding solutions in science and society

The goal of the David Suzuki Foundation is to study the underlying structures and systems which cause environmental crises and then work to bring about fundamental change. We do this in four ways:

Research: The David Suzuki Foundation seeks out and commissions the best, most up-to-date research to help reveal ways we can live with nature.

Application: We support the implementation of ecologically sustainable models – from local projects, such as habitat restoration, to international initiatives, such as better frameworks for economic decisions.

Education: We work to ensure the solutions developed through research and application reach the widest possible audience, and help mobilize broadly supported change.

Advocacy: We urge decision makers to adopt policies which encourage and guide individuals and businesses, so their daily decisions reflect the need to act within nature's constraints.