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CARBON DIOXIDE EMISSIONS AND FEDERAL ENERGY POLICY

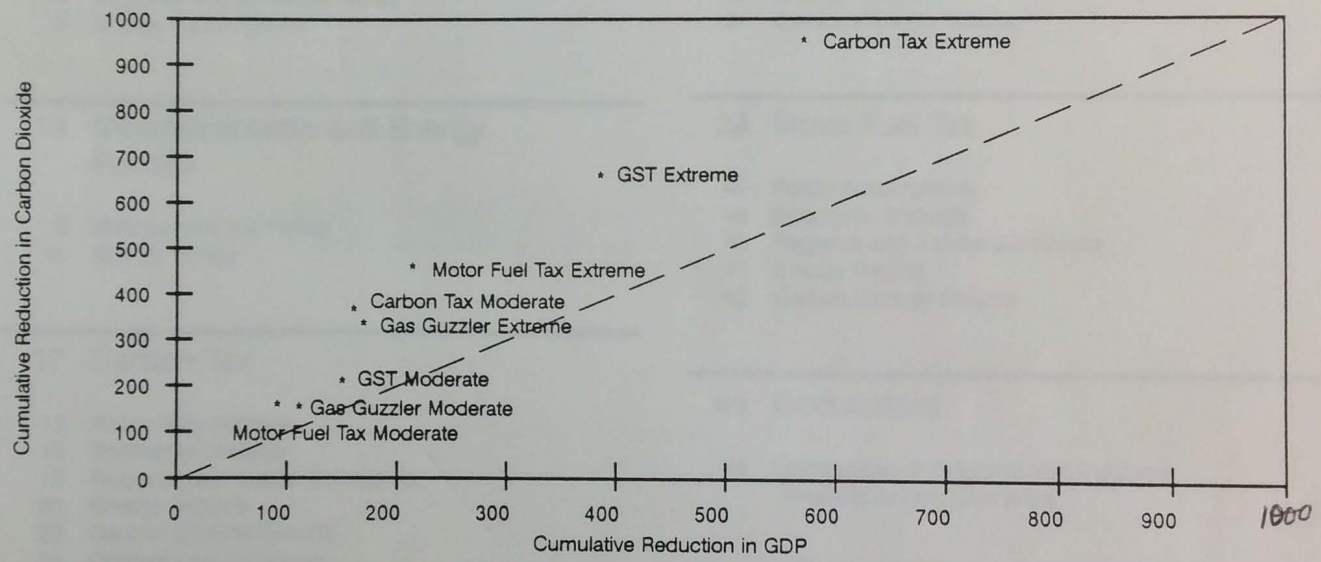
April, 1991

Esso
Imperial Oil

Carbon Dioxide Emissions and Federal Energy Policy:

A Discussion of the Economic Consequences of Alternative Taxes

Cumulative Reduction in Carbon Dioxide Emissions and the Associated Cost (Reduction) in GDP
(Million tonnes and billion 1981 dollars at factor cost, 1990 to 2005)



Diagonal Line Represents $1000 Per Tonne CO_2 Reduction Cost

Prepared for
Imperial Oil Ltd.

by
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Executive Summary

Carbon dioxide is produced in varying amounts by every economic activity in Canada. The Canadian government, in cooperation with other nations, is committed to reducing the potential environmental consequences of greenhouse gases such as CO_2. An effective control policy would cause carbon dioxide and other greenhouse gases to diminish with a minimum effect on the day-to-day operation of the Canadian economy. This study analyzes the economic consequences of curbing CO_2 emissions through the proposed introduction of both Carbon and Gas Guzzler Taxes, and increases in the newly introduced Goods and Services and Motor Fuels Taxes.

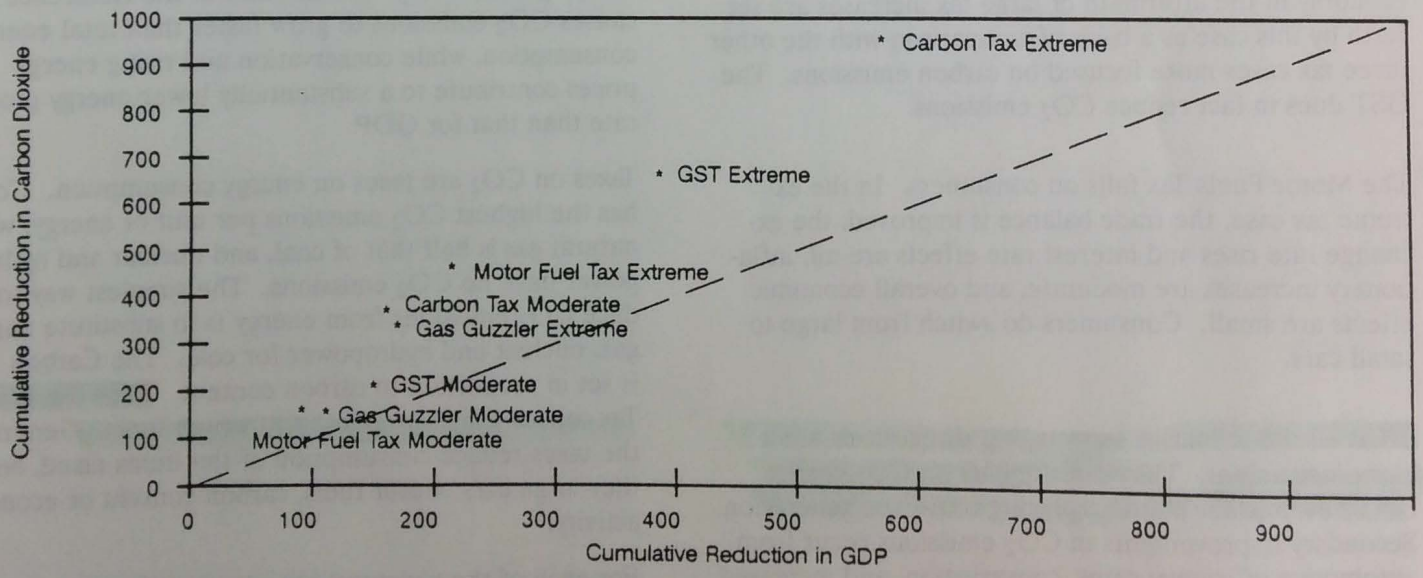
A Carbon Tax causes the most direct impact on CO_2 since the tax is in proportion to the emissions. Electric utilities would have considerable incentive to build new nuclear or hydro plants, since these sources produce no CO_2. The Canadian oil and gas industry, which is heavily concentrated in Alberta, would be harshly penalized. The paper, chemicals and primary metals industries would face severe cost increases. Production of coal would falter while heavy oil would virtually cease to be a usable resource. Those provinces with extensive nuclear and hydro power would experience an accelerated switch to electricity, especially for electric heat.

The Gas Guzzler Tax falls on the production and sale of motor vehicles in the commercial and family-size categories. Since Ontario produces many such vehicles, the greater onus of the tax is borne in that province. In general, manufacturing industries fare poorly. Also,

CHART 1

Cumulative Reduction in Carbon Dioxide Emissions and the Associated Cost (Reduction) in GDP

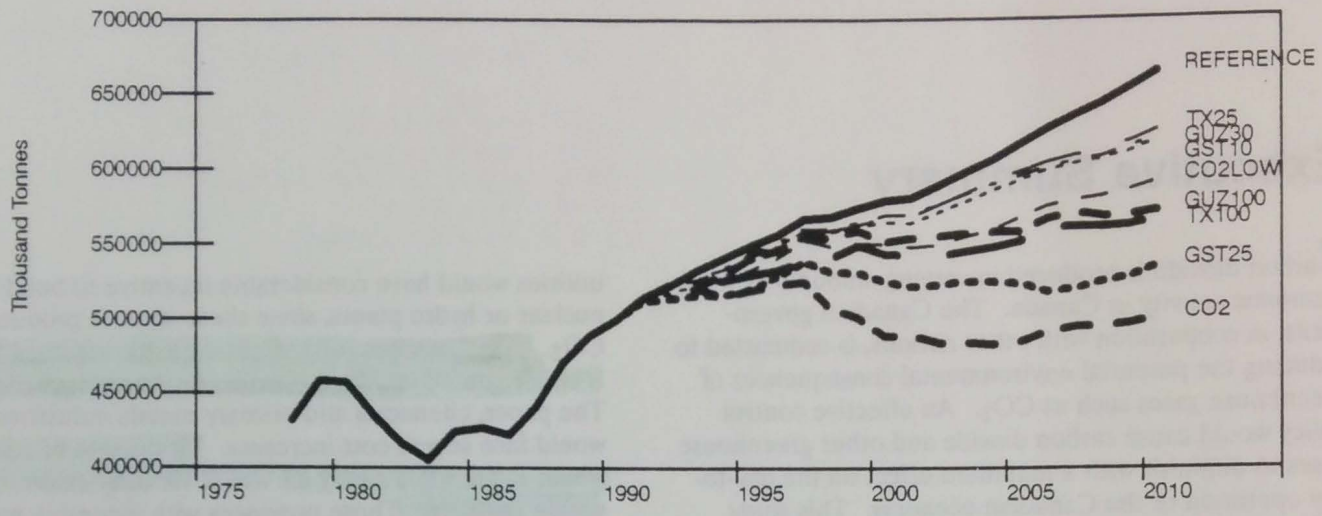
(Million tonnes and billion dollars ($1981) at factor cost, 1990 to 2005)



Diagonal Line Represents $1000 Per Tonne CO_2 Reduction Cost

CHART 2

Carbon Dioxide Emissions Growth – 1978 to 2010 Reference Case



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trade is adversely affected since Canada would import proportionately more vehicles.

The Goods and Services Tax was introduced on January 1, 1991 at a rate of 7 percent. This tax is increased to 10 percent in the moderate version and 25 percent in the extreme case. The main thrust of the GST is to raise revenues for the federal government. How those revenues are respent and the workings of the Canadian economy in the aftermath of large tax increases are set forth by this case as a basis of comparison with the other three tax cases more focused on carbon emissions. The GST does in fact reduce CO_2 emissions.

The Motor Fuels Tax falls on consumers. In the extreme tax case, the trade balance is improved, the exchange rate rises and interest rate effects are nil, inflationary increases are moderate, and overall economic effects are small. Consumers do switch from large to small cars.

What all the scenarios show is that direct taxes are a blunt instrument. The major impact on CO_2 comes from new nuclear plants replacing coal-fired generation. Secondary improvements in CO_2 emissions occur from automotive efficiency gains, conservation, and increased use of natural gas. The Gas Guzzler Tax is a particularly inefficient way of reducing CO_2 emissions since its primary effect is to reduce manufacturing activity and imbalance existing international trade patterns.

In 1990, Canada will emit about 500 million tonnes of CO_2 while consuming over 12,000 petajoules of energy and producing a GDP of 684 billion dollars. In the Reference Case, CO_2 emissions rise to 616 million tonnes by 2005 while energy consumption grows to 16,000 petajoules and GDP to 1072 billion dollars ($1990). The increasing reliance upon fossil fuels in the Reference Case causes CO_2 emissions to grow faster than total energy consumption, while conservation and rising energy prices contribute to a substantially lower energy growth rate than that for GDP.

Taxes on CO_2 are taxes on energy consumption. Coal has the highest CO_2 emissions per unit of energy, while natural gas is half that of coal, and nuclear and hydro power have no CO_2 emissions. The simplest way to reduce CO_2 emissions from energy is to substitute natural gas, nuclear and hydropower for coal. The Carbon Tax is set in proportion to carbon content. Thus the Carbon Tax causes a high propensity to switch fuels. Generally, the taxes reduce consumption of the items taxed, be they large cars, motor fuels, carbon content or economic activity.

For each of the tax cases, two alternatives were prepared featuring a moderate version and an extreme version of the tax. For example, the Carbon Tax is intro-

duced at $50 per tonne of carbon emitted in the moderate case and at $200 per tonne in the extreme case. Consequently, a total of eight different tax scenarios are compared with a moderate and extreme version of each of the four taxes.

All of the cases can be compared in terms of their economic efficiency in reducing CO_2 in a measure of dollars per tonne. The cumulative loss in real GDP between 1990 and 2005 is a measure of the social investment made in CO_2 reduction. Also, the tax revenue collected on energy consumption by the given tax would be a measure of the relative burden on society of undertaking CO_2 reduction by use of taxes. The cumulative reduction in CO_2 emissions is the result.

In principal, the best policy to reduce CO_2 would be the one most cost effective. Cost effectiveness is shown by comparing cumulative CO_2 emissions with cumulative GDP reductions in Chart 1. If a line were drawn at the ratio of $1000 per tonne of CO_2 emissions avoided, most of the scenarios would be to the left, indicating a cost of less than $1000 per tonne. The Gas Guzzler Tax is closest to the right, indicating a higher cost. In Chart 2, the results of the eight scenarios are compared for the annual level of CO_2 emissions.

Introduction

Carbon dioxide is one of several greenhouse gases that are considered contributors to global warming. Many developed nations are accepting global warming as an inevitable consequence of the buildup of greenhouse gases in the atmosphere. There is no doubt that CO_2, methane, CFCs and nitrous oxide are increasing in atmospheric concentration. Thus, governments around the world are seeking new actions that limit the build up of greenhouse gases.

The essence of policy measures is to reduce the emission of carbon dioxide by taxing energy consumers. Grand goals such as a 20 percent reduction in carbon dioxide emissions from current levels have been proclaimed. The Canadian Minister of the Environment has set a goal of stabilizing carbon dioxide emissions in 2000 at current levels. Such goals for carbon dioxide emissions imply new energy policies, including new taxes.

Canada has already had experience in reducing carbon dioxide emissions by large amounts. From 1980 to 1983, carbon dioxide emissions in Canada fell from 456 million tonnes to 404 million tonnes as calculated using CO_2 coefficients and energy consumption.

The economic circumstances that led to a reduction of carbon dioxide were severe. Energy prices nearly doubled during this period and a very deep recession occurred. No consumer would willingly return to the 20 percent interest rates and double-digit unemployment rates that characterized the economy of this era. The reduction in CO_2 from 1980 to 1983 was not brought about by environmental policy. However, examination of this era serves to indicate the potential dangers in a single-minded greenhouse-gas emission reduction plan.

Energy policies did have much to do with the reduction of carbon dioxide emissions in the early 1980s. Natural gas was substituted for petroleum, and massive new hydroelectric generating stations featuring flooding of the LaGrande River Basin reduced fossil fuel consumption in Quebec. Ontario Hydro constructed the Pickering and Bruce nuclear stations while Gentilly and Point Lepreau were built in other provinces. All of these measures helped reduce carbon dioxide levels. Carbon dioxide reduction was initially accomplished by recession, inflation and fuel switching. In addition, the 1980 energy policies altered industrial consumption patterns.

High energy prices encouraged pulp and paper companies to install bark boilers, which have one of the highest CO_2 emissions rates. Wood burning releases 100 tonnes of CO_2 per petajoule, while natural gas releases 49 tonnes.

Hydroelectric sites do not produce carbon dioxide. However, they do flood large areas of vegetation, which reduces the absorption of CO_2 by photosynthesis. Bodies of water such as oceans and lakes also absorb CO_2. The point is that biomass and hydro projects also interact with the environment. Scientific evidence offers fewer certainties than would be desirable for informed public policy.

Other environmental concerns were heightened in the past decade. Nuclear accidents at Three Mile Island and Chernobyl have heightened concerns about nuclear safety. Also, the final resting place for spent nuclear fuel is as yet undecided.

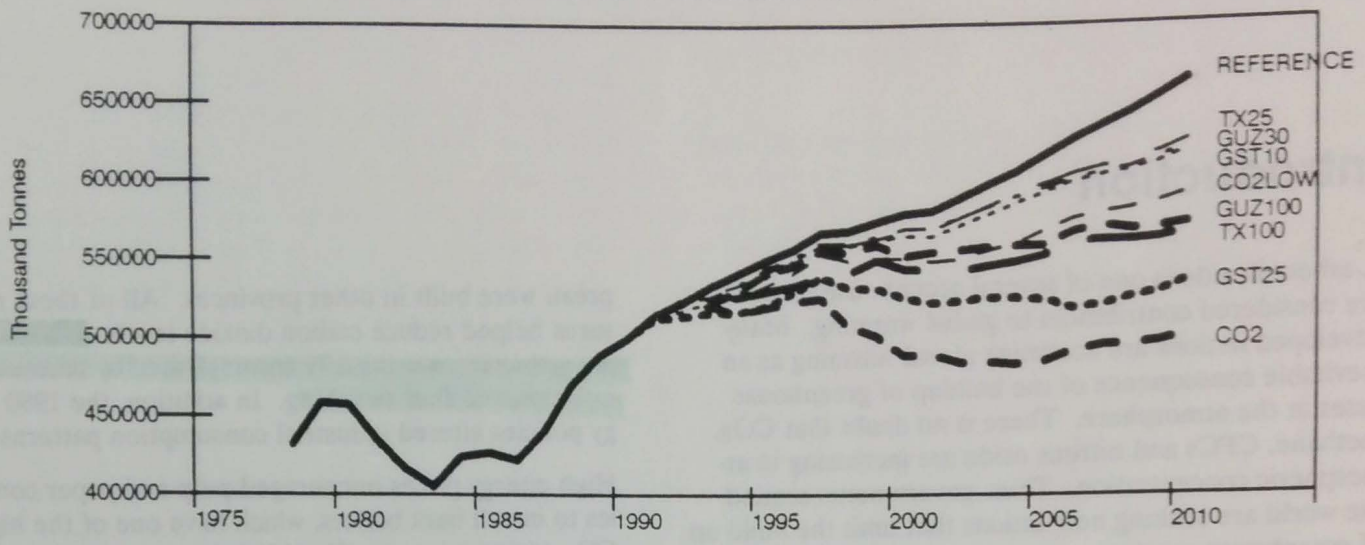
Clearly, the experience of the 1980 to 1983 price shock and recession was painful for energy consumers and producers. Economic shock was accompanied by government intervention in market decisions. Such events ultimately disrupt normal economic, commercial and political decision-making. In particular, political decisions carry an inherent responsibility to all parts of society such that a single-minded goal is usually unworkable. Tradeoffs must be made between CO_2 reduction, economic growth and other environmental issues.

In many forums, the Canadian government has discussed the use of taxation to effect environmental goals. Economic analysis of such options will help the government make prudent decisions.

While the details of the proposed Environment Canada policies are still taking shape, newspapers and government agencies have been discussing various taxes. Four

CHART 1

Carbon Dioxide Emissions Growth – 1978 to 2010 Reference Case



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tax cases are representative of possible policies—a Carbon Tax, increases in the Goods and Services (GST), increases in the Motor Fuel Tax, and a Gas Guzzler Tax involving a one-time sales tax on larger cars followed by higher annual registration fees.

Of particular interest is the effect such taxes would have on the macroeconomic and industrial structure of the Canadian economy. Energy-intensive industries obviously would have the primary impacts in terms of fuel choice, cost of doing business, trade patterns, and investment. Electric utilities would face complex choices, with massive consequences for CO_2 emissions.

This study, commissioned by Imperial Oil Ltd., is a formal analysis of the economic impacts and reduced CO_2 levels resulting from selected government tax policy. In order to proceed with this analysis, DRI/McGraw-Hill has developed the appropriate assumptions to fully reflect the consequences of the government tax policy within its existing economic and energy modeling system.

Reference Case

In the Reference case, current policy stays intact, there are few disruptive events, and economic growth proceeds at a normal rate. World oil prices rise in real terms, the economy grows at 3% per year, inflation is moderate, and the federal deficit is in retreat by 1998.

Resource prices increase in real terms such that mining, manufacturing and services all substantially contribute to economic well-being.

Energy demand growth averages 1.7% per year, about 0.55 the rate of increase of the entire economy. Conservation programs, demand management, automobile efficiency, and real price increases temper energy demand growth. Natural gas demand is enhanced by increased use in electricity generation and more stringent requirements for clean fuel. Nuclear power overcomes the current impasse, and both Ontario and New Brunswick construct new nuclear stations.

Energy development focuses on replacing the diminishing supply of conventional crude oil with such projects as Hibernia, Terra Nova, Beaufort and Oil Sands. The Mackenzie Delta pipeline is constructed in 1999, thus ensuring ample supplies of natural gas to meet growing demands. Canadian electric utilities spend over 30 billion dollars on conservation and demand management, with a target of 11,000 megawatts of generation equivalent by 2010.

In 1990, CO_2 emissions reach 500 million tonnes. Carbon dioxide emissions continue to rise, reaching 616 million tonnes in 2005 and 664 million tonnes in 2010. The level of carbon dioxide emissions have been calculated by province for the period form 1978 to 2010 based upon CO_2 coefficients obtained from Energy Mines and Resources and the Ontario Ministry of Energy.

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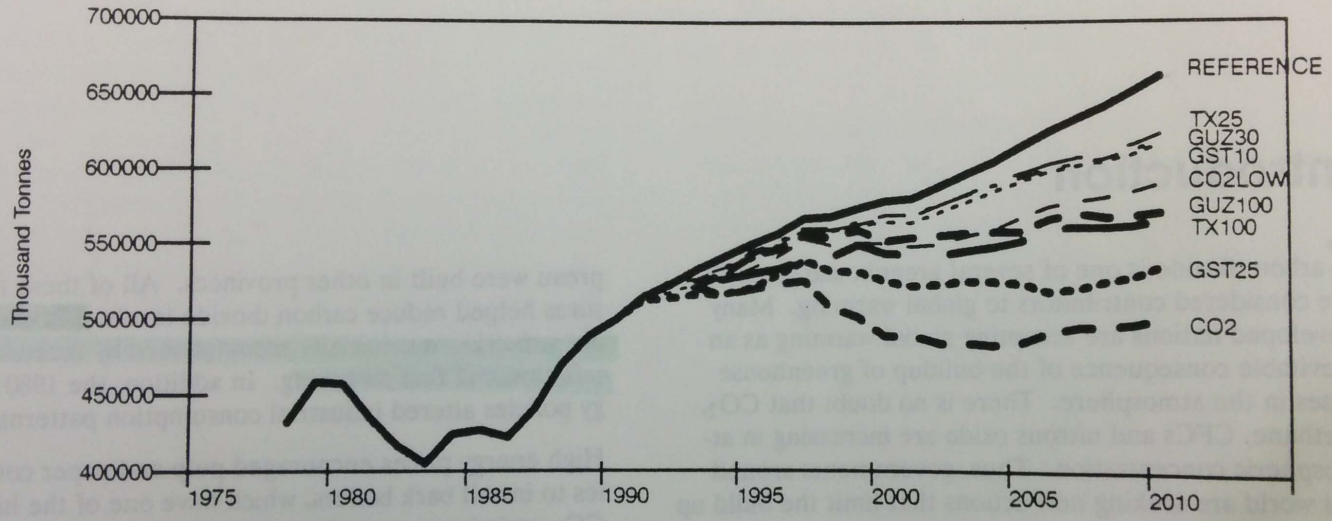

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Energy demand

Scenario Assumptions

There are nine scenarios developed for this study, including a Reference Case and four tax cases, each with a moderate and an extreme version. This section discusses the methodology used in the analysis and the key assumptions made for each scenario.

Methodology

A comprehensive modeling exercise includes several steps. First, the assumptions are carefully prepared. The tax cases are contrasted to a base case which is a long-term trend forecast extended to 2005. The 15 years, 1990 to 2005, measure both the initial and the long-term economic impacts of the aforementioned tax increases.

The results of models reflect how society would adapt to new policies. New taxes imply that consumers and producers would face higher costs, while governments would have more revenues. The macroeconomic impacts of tax changes include inflation, growth, exchange rates, investment and trade, and are relatively easy to identify.

The microeconomic effects on specific industries are much more difficult to establish without a comprehensive framework such as those provided by related industry models. Since most of the taxes are aimed at energy consumption, a large scale model of Canadian energy markets is also used in this study.

The energy model is used to calculate energy consumption. Total CO_2 emissions are derived from energy demand using CO_2 coefficients developed for models by Energy Mines and Resources, and the Ontario and British Columbia Ministries of Energy.

Several aspects of how CO_2 tax policies will impact society are addressed in this study at the level of Macroeconomics, Regional, Industry and Energy. The Macroeconomic model has an associated industrial model with an imbedded input-output framework to establish impacts at the level of industrial detail. The Energy model measures effects on oil and gas supply as well as energy demand and trade. The Regional model shows the distribution of effects across provinces, particularly the differences between the producing and consuming regions of Canada.

Imperial Oil Ltd. is undertaking a comprehensive analysis of alternative tax policies on the Canadian economy and CO_2 emissions. The assumptions used in this analysis reflect two alternatives for each policy—a moderate compromising policy, and an extremely harsh, repressive policy. The key assumptions that are required to analyze the government tax policies are as follows:

- Each of the taxes has a different incidence based upon the level of the tax, its intended incidence, and its intended consequence. For example, a carbon tax would be set in dollars per tonne of carbon emission on fossil fuels, the GST increased across the board on all goods and services, the motor fuel tax raised in cents per litre for gasoline and road diesel, and a gas guzzler tax established on the least fuel-efficient passenger cars and light trucks (new and existing) in Canada. The total tax revenue is calculated using the Canadian Energy Model.
- How the tax revenue is spent is of major importance to the economic results. Essentially, government accrues the extra revenues from the new tax until budget balance is achieved. The tax revenues are then spent on transfers and new programs. The same government spending pattern is applied to all of the scenarios. In addition to the spending patterns imposed in these scenarios, various forms of trading or cross crediting could be allowed.
- The carbon content of each fuel is specified. Combustion efficiency can alter the amount of CO_2 emitted. Carbon taxes are based upon the CO_2 emission coefficients. CO_2 emissions are calculated by fuel, sector, and province.
- International competitiveness is a critical aspect of taxation policy. In a mild tax case we assume that other countries are adopting similar policies so that international competition is less significantly af-

fected. In the extreme cases, the full debilitation of international trade brought about by taxation would occur. International cooperation is ultimately the deciding factor for a successful CO_2 emission reduction plan. International competitiveness is reflected in the Macroeconomic model through the exchange rate and relative price effects on trade.

Macroeconomic Assumptions

This section identifies the policy responses assumed for the carbon tax scenarios. Since policy can have a substantial impact on the economy, it is critical that the behavior assumed by the fiscal and monetary authorities is identified. It is also important that these assumptions are consistent, so that comparisons between scenarios are appropriate.

In each scenario, a tax policy was introduced that ultimately attempted to lower CO_2 emissions. This had the direct effect of raising federal government revenue and inflation while weakening the economy. In light of the direct changes to the economy, the following responses were assumed in all cases:

Monetary Policy

Short-term interest rates were increased by the amount of the increase in inflation, thus real short-term interest rates were unchanged. No additional adjustments were made to long-term rates, which move by approximately 25-35 basis points for each 100 basis points (or 1 percent) move in short-term rates. This response was consistent with the Bank of Canada's unwillingness to accommodate any increase in inflation, and therefore was assumed to respond to increases in inflation with an equal dose of higher interest rates.

Fiscal Policy

All net revenue flows from the increased taxation were used to lower the deficit until it achieved balance. This simply reflects the reality of the current deficit, which has stagnated near $30 billion in each of the last five years; and a debt-to-GDP ratio that is at its highest level since World War II, and is still growing. In our base case, the National Accounts deficit balanced in 1998 (approximately 4 years later than the Department of Finance is projecting), but the higher tax revenue accelerated that by up to 2 years. Once the deficit was balanced, it was assumed that the federal government would respend all additional revenues; thus the improvement in the deficit in the year it was balanced was maintained to the forecast horizon. In the moderate cases, this improvement was roughly $7-$8 billion; in the extreme cases it was $12-$14 billion. The improvement was larger in the exteme cases because the momentum from the sharper tax increases caused the deficit to balance sooner than in the moderate cases. Thus, relative to the base case that showed a gradual reduction in the deficit over time, the improvement required to balance the budget was greater the sooner it took place.

Federal government respending was divided between additional spending on current goods and services, transfers to persons, and income tax cuts. This division is intended to spread the respending over the principal revenue and expenditure components so that a similar balance between programs could be maintained. Since the amounts for each component were allocated to maintain a given improvement in the deficit, the specific mix chosen has little bearing on the overall simulations effects.

Other Key Factors

- The Canadian dollar was allowed to float; no additional adjustments were made to it. The effect of the higher interest rates and improved trade balance (from the weaker economy) typically caused a mild appreciation at the beginning of the period; subsequently, the higher inflation and reduced competitiveness caused it to weaken.

- The wage response to inflation changes was not accelerated; thus the effects of the policies were unanticipated in labor negotiations prior to their impact on reported inflation.

- The federal government was not assumed to initiate any new stabilization policies in the face of the weaker economy that emerged prior to the respending of revenue gains. This reflects the onerous level of the deficit and debt that does not permit action on any meaningful scale. However, the full effect of the automatic stabilizers (such as unemployment insurance) were operational, as was the maintenance of the same volume of spending on goods and services and transfers to the provinces.

Other Notes

Compounding. Care must be taken when interpreting nominal values because of the effects of compound growth. For example, by 2005 the economy in current dollars is more than three times its present size. A federal deficit equivalent as a share of GDP to its $30 billion level today is $90 billion in 2005, as is a debt of

$1.05 trillion (compared with $350 billion at the end of fiscal 1989–90).

Deficit Changes. An explosive dynamic can cause large changes in the deficit from seemingly small initial impacts. This is because extra revenue, for example, reduces the deficit directly, which in turn lowers the debt and subsequently interest payments. These in turn lower the deficit, which again lowers interest payments, etc. To illustrate, a $1 direct change in the deficit in 1990 will lead to a $4 change by 2005, with the $3 effect on interest payments dominating the original change.

Regional and Industrial Notes

The eight macroeconomic simulations described in the previous section were used to construct corresponding simulations using DRI's Industrial and Regional models. Using an input–output structure and the final demand categories of the macroeconomic model, the industry model produces forecasts of industrial output for approximately 40 industries. The regional model then uses the output of the industrial and Macroeconomic models to simulate economic activity within seven regions (six provinces and the Atlantic region) in a dynamic, simultaneous fashion, while ensuring the add-up to the previously solved national levels.

It is important to recognize that output in the industrial and regional models is defined at factor cost, while total output (real GDP) in the macroeconomic model is defined at market prices. Real output at market prices/ less indirect taxes/plus government subsidies is, by definition, equal to real output at factor cost. As a result, in the extreme case, real output at market prices declines by a cumulative amount of $100 billion, while real output at factor cost declines by a cumulative $566 billion. The difference between these two declines is the cumulative amount of increased indirect taxes that are collected as a result of carbon taxes.

Energy Assumptions

Each of the four tax scenarios has a moderate and an extreme scenario for a total of eight scenarios. The energy assumptions for the moderate cases are the same except for slight modifications of the carbon tax and gas guzzler cases. The extreme case has accelerated conservation, more natural gas vehicles, and more nuclear and less coal consumption. There are slight modifications of the extreme case assumptions made for the carbon tax and gas guzzler (see Table 1).

TABLE 1
Energy Assumptions Used in the Moderate and Extreme Alternatives of Each Tax Scenario

	Moderate CO_2	Extreme CO_2
Coal Plants	none after 2003	none after 1998, existing coal plants replaced with other fuels such as nuclear
Nuclear Plants	Alberta adds gas, other provinces add nuclear or hydro as required. Carbon Tax case has additional 900 megawatts	all add Nuclear plants Carbon Tax case has additional 7200 megawatts
Conservation and Demand Management	200 megawatts per year added to 11,000 megawatts total in Reference Case	400 megawatts per year added to Reference Case
Natural Gas Vehicles	2% of new car sales	10% of new car sales

Macroeconomic and Energy Policies

Fiscal policy, especially taxes and respending, are the initial causes of the results of this study. The price changes induced by the taxes have further effects on interfuel substitution. And the consequences of the taxes—CO_2 emission reductions—must be measured against other environmental policies.

Macroeconomic Policy

The principal macroeconomic issues involve respending. The federal government can recycle the tax revenue by deficit reduction, cutting other taxes, increasing transfers to individuals through such things as the GST credit and program spending. Spending is divided between deficit reduction, transfers, and programs.

Deficit Reduction

All of the tax revenue is used to reduce the deficit until the budget is brought into balance, which would be in the late 1990s. Federal budgetary balance is achieved by 1998 in the base case and by 1996 in some of the energy tax cases. The tax rates have a smooth implementation, such as introducing the GST at a rate of from 1 percent to 2 percent per year, thus causing a continual increase in government revenues.

Transfers

Government transfers include the proposed GST credit, which causes a transfer payment to low income individuals whose existing level of income and spending patterns make the GST regressive. Since all of the proposed taxes are regressive, additional transfers or credits are consistent with current government views on respending.

There are other ways of offsetting tax revenues. The personal income tax could be reduced or adjustments made to other taxes such as unemployment insurance (U.I.) and the Canadian Pension Plan or Quebec Pension Plan.

Program Spending

There are numerous prospective programs that could improve environmental quality such as assistance to international efforts to ban CFCs and clean up of the Great Lakes. Government program spending is targeted on specific activities which have in turn effects on economic activity such as energy demand.

Federal programs could also address interfuel substitution and promote conservation, demand management, electricity use in mass transit, and nuclear generation, thus significantly reducing fossil fuel consumption in Canada.

Recycling. Many communities have begun voluntary recycling programs. Also, many newspapers and magazines want to use recycled paper for ecological reasons and public recognition. The petrochemical industry recycles plastics and will be able to increase recycling dramatically in the future. Federal program monies could be spent on promoting recycling programs.

Great Lakes Cleanup. The Great Lakes clean up consists of water treatment plants for effluent at the point of entry, such as towns and mills with discharges into rivers and streams that flow into the Great Lakes.

Mass Transportation. There are subways, light rail transit, commuter trains, and VIA rail and bus lines that provide enormous transportation services at relatively low emissions of pollutants per passenger.

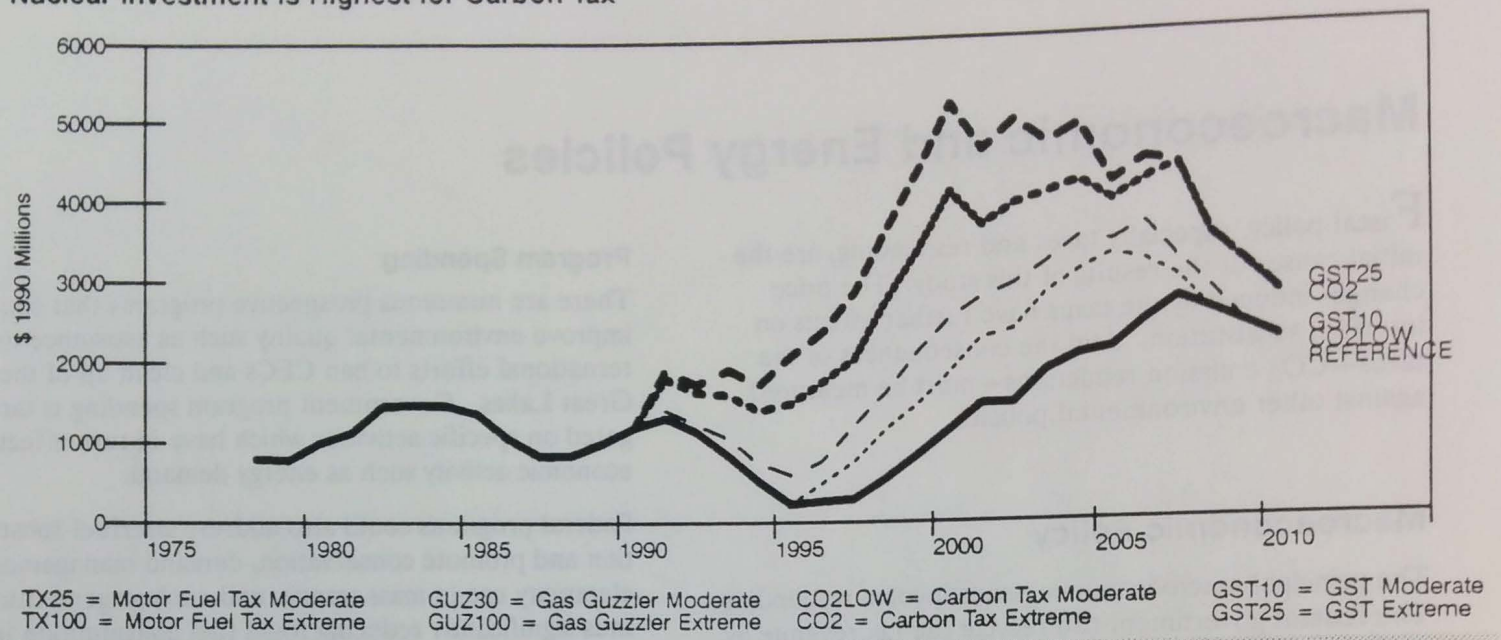
Rail Electrification. Electricity generated by nuclear or hydroelectric sources could be used to power railroads.

Conservation and Demand Management. Electric utilities have made enormous commitments to conserving electricity. Ontario Hydro is committed to spending several billions of dollars to reduce the demand for electricity at specific sites and for specific processes.

Nuclear Plants. Atomic Energy of Canada Ltd. (AECL) is the major provider of nuclear technology in Canada. Several nuclear stations have been partially funded by AECL, either through research and development or provision of technology. Nuclear generation of

CHART 1

Nuclear Investment Is Highest for Carbon Tax



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electricity would require a major contribution by the federal government to induce provinces such as Saskatchewan, Manitoba and British Columbia to add nuclear capacity.

Investment

The base case investment provides for the energy, infrastructure and producing capacity of an economy growing by nearly 3 percent per year. The base case capital stock is nearly fully employed, with both domestic demand and exports of Canadian goods growing. The pattern of growth is very much a reflection of Canadian traditional strengths in resources and includes several megaprojects.

A major reduction in allowed CO_2 emissions would impact the investment profile in two ways. First, the megaprojects such as OSLO and Hibernia could be canceled. Development of large scale oil projects is not necessarily linked to Canadian demand for petroleum products, so these projects could proceed if world oil prices are high enough. A concerted effort to reduce world oil consumption would probably chill the economic prospects for development of either or both of these projects.

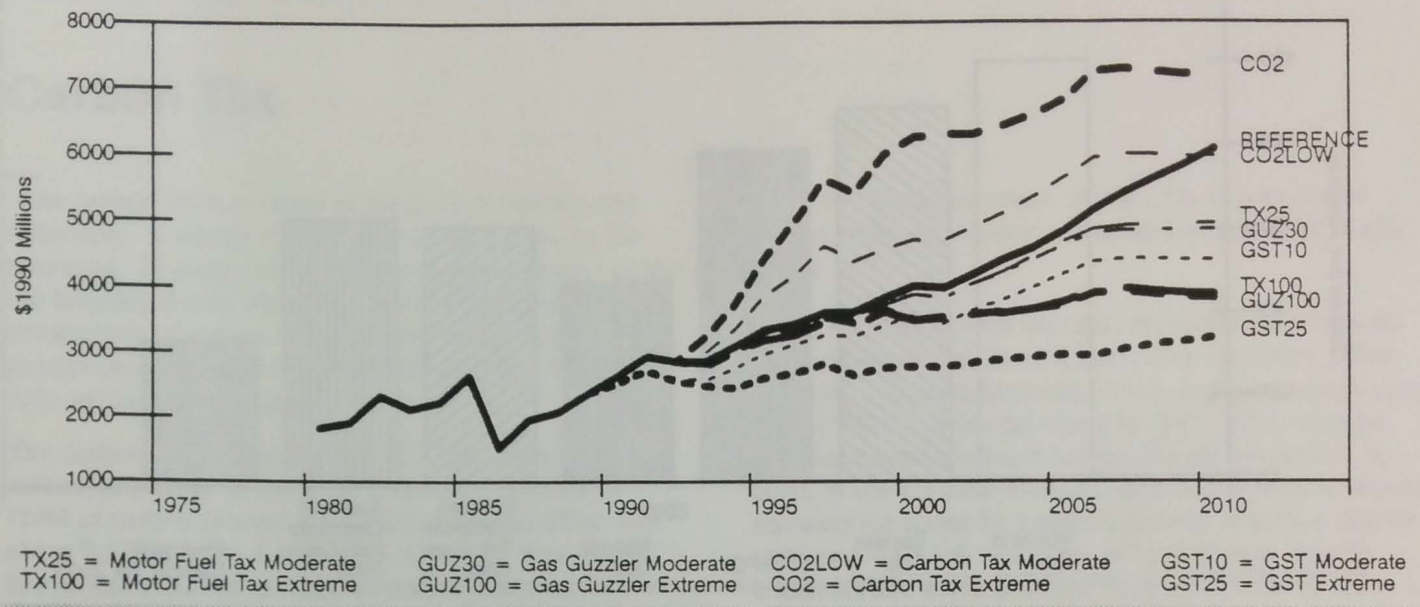
A program to reduce oil and coal consumption would lead to the closing of refineries and coal mines—a significant reduction in the capital stock of Canada. Converting railroads to electricity would cause a reduction in the demand for diesel locomotives. Change of economic activity from coal and oil to electricity would cause considerable investment by the utility sector. Nuclear plants costing on the order of Darlington would be added, while the existing coal plants would presumably remain in the rate base but not be used. In a real sense, the loss of wealth caused by capital that is retired before its useful life ends represents a large loss of wealth for Canada.

Second, the need for clean energy resources such as natural gas, nuclear and hydro power will result in a major shift in investments from the base case. While these investments may be subsidized by government programs, the overall cost to the economy will be dependent upon the relative cost of these new sources of energy.

To a large extent, these energy resources are capital intensive, with enormous initial investments, low operating costs, and fairly long pay back periods. The profile of new investments implies that the Canadian economy will receive a strong initial stimulus from investment and a considerable increase in borrowing and ultimate repayment of debt.

There are two aspects of the energy resources investment, including the loss of part of Canadian current economic infrastructure and the large scale investments required in new technologies. In terms of the economic

CHART 2
Utility Fuel Cost Increases With Carbon Tax



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impacts of a carbon dioxide tax, provision is made for effects on potential GDP, delay or cancellation of mega-projects, and expanded investment in new areas.

Ultimately, the economic implications of CO_2 taxes will be evident in Canadian international competitiveness. If investments offer poor returns and lead to losses in international markets, the overall economy will suffer.

International Competitiveness

Canadian international competitiveness is concentrated in resource-based energy intensive industries such as metals, pulp and paper, and energy. A major consequence of raising the price of energy is a loss in international competitiveness.

Another effect of high taxes on energy consumption is increased inflation. The full effect of higher inflation would lead to a combination of higher interest rates and a depreciation of the exchange rate.

In the moderate policy cases, the assumption of a cooperative international regime is made. Most countries would impose policies symmetric to those in Canada. In particular, the U.S. would mirror Canadian polices so that there is little effect on the exchange rate.

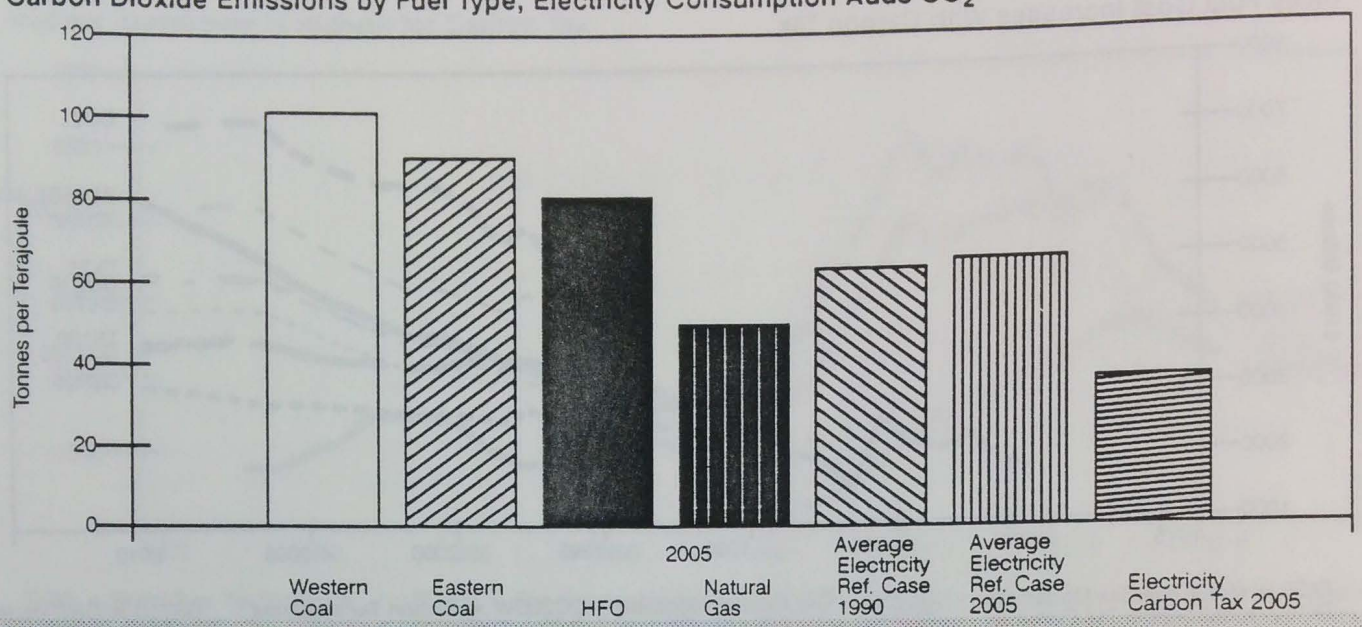
In the extreme policy regime, Canada goes it alone. High taxes on energy consumption are borne by the manufacturing and resource sector. Canada becomes less competitive in international markets. A decline in international competitiveness would lead to depreciation of the Canadian dollar. This is accomplished in the model by fixing the Canadian dollar at its real exchange rate.

International considerations are critical. Note that if the U.S. reduced CO_2 emissions by 30 percent it would delay the doubling of world atmospheric CO_2 concentration from 80 to 85 years at a cost to the U.S. of 150 to 200 billion per year. The benefits to the U.S. would be minimal since mainly the agricultural sector and low lying tidewater regions are affected by global warming.

The Third World, which has a major portion of its economy in the agricultural sector, has much more serious economic exposure to global warming. Thus the assumptions we make on international cooperation are of the greatest consequence for CO_2 emissions and global warming.

CHART 3

Carbon Dioxide Emissions by Fuel Type, Electricity Consumption Adds CO_2



Energy Policy

Interfuel Substitution

Events in the past decade accentuate the importance of electricity fuel choice in determining energy market trends. All of the critical fuel switching decisions involve electricity and the fuels used to generate electricity. The most effective policies to reduce carbon dioxide emissions are those that reduce CO_2 emissions from the electric utility sector.

Canadian consumers have undertaken a massive switch in fuel sources in the past decade as a consequence of rising oil prices, government programs and expansion of natural gas pipeline availability. Electric utilities have avoided oil and chosen nuclear, hydro electricity and coal. Paper companies have installed numerous bark boilers and now rely upon wood waste for much of their fuel requirements.

Electricity has maintained its role as a superior good—electricity demand has grown faster than the economy as a whole. This means that electricity has grown very rapidly in electricity-only uses such as air conditioning, and has partially replaced fossil fuels in areas such as space heating. Since it takes about three units of fossil fuel to generate one unit of electricity, which then replaces about one to two units of fossil fuel, there is a potential net increase in carbon dioxide emissions when electricity is used for space heating.

Other interfuel substitution is imposed in the scenarios. Nuclear power is introduced in all of the regions. Natural gas vehicles are added at a rate of 10 percent of new vehicles. Price induced substitution is measured within the energy model. The net result is a major change in market shares across cases.

Carbon Tax

The carbon tax is a matched focus to carbon dioxide reduction: it exactly corresponds to what is being discouraged. In comparison, the goods and services tax has the broadest focus, with a tax increase on everything, irrespective of carbon content. The motor fuel and gas guzzler taxes are narrowly focused, with direct taxation only on the transportation sector.

The carbon tax is assessed in dollars per metric tonne of carbon contained in the CO_2 emissions. (Carbon is 12/44 of carbon dioxide.) One barrel of petroleum has about 0.122 tonnes of carbon content, and thus would have a tax of $24.40 per barrel in the $200 extreme carbon tax scenario.

There are two carbon tax scenarios: a $200-per-tonne extreme tax; and a $50-per-tonne moderate tax. In the extreme carbon tax scenario, the carbon tax is first applied in 1993 at the rate of $25 per tonne of carbon emissions. After 1993, the extreme tax increases by $25 per year until reaching $200 in 2000. The real value of the carbon tax is maintained in 1993 dollars. Thus the $200 tax in 2005 amounts to $381 in as-spent dollars.

The moderate tax starts at $10 per tonne and is increased by $10 per year, reaching $50 per tonne in 1997 or $57.87 in as-spent dollars. The moderate tax reaches $87.28 in 2005 in as-spent dollars, reflecting a somewhat lesser rate of inflation than in the extreme carbon tax scenario.

The carbon tax causes a reduction in CO_2 emissions in three ways: weaker economic activity, price-induced conservation and efficiency, and fuel switching. While the carbon tax is massive and causes a substantial reduction in economic activity, fuel switching is potentially the biggest source of CO_2 reductions. For example, nuclear power would be unaffected by a carbon tax, while coal and other fossil fuels would be harshly penalized by such taxation. Thus, electric utilities would be strongly attracted to nuclear power in the carbon tax case.

In the carbon tax scenario, Canadian utilities add over 7,200 gigawatts of nuclear capacity above and beyond the Reference Case by 2005. More nuclear capacity is also added in the other scenarios. However, in the narrowly based tax scenarios, much of the CO_2 impact comes from a weaker economy, conservation, and vehicle efficiency.

In the extreme carbon tax case, economic activity is depressed: there are fewer homes, cars, factories, office buildings and electric power plants, and personal income is over 7% lower in real terms by 2005. This reduced economic activity affects carbon dioxide emissions. Indeed, in the extreme scenario, reduced economic activity accounts for about 34.5 million tonnes of carbon dioxide reduction—a 5.6% reduction in total carbon dioxide emissions and more than one-quarter of the reduction in carbon dioxide. The remaining three-quarters of the reduction is a result of interfuel substitution, along with price changes and conservation efforts.

Interfuel substitution includes using natural gas rather than other fuels. Natural gas use is only partially promoted by the carbon tax. Natural gas emissions of 49 tonnes of carbon dioxide per terajoule are only two-thirds those of fuel oil (at 73 tonnes). Thus the carbon tax amounts to over $8 per gigajoule for fuel oil and about $5 per gigajoule for natural gas. There is more of an incentive to switch from natural gas to primary electricity—thereby saving $5 in taxes per gigajoule—than there is to switch from fuel oil to natural gas at a savings of $3 per gigajoule.

Additional government policies promoting natural gas are assumed in the extreme carbon tax case. Specifically, natural gas vehicles reach 10% of new vehicle sales by 2005. This reduces carbon dioxide emissions by 1.4 million tonnes (about 1% of total emissions reductions). Switching from oil to gas in other sectors provides another 1.8 million tonnes of carbon dioxide reduction. In total, switching from oil to other fuels accounts for about 2% of carbon dioxide reduction.

The results of the extreme carbon tax case suggest that the switch from coal to nuclear fuel (a 7200 megawatts increase in nuclear and a 5900 megawatts reduction in coal capacity) accounts for 32% of the total reduction in carbon dioxide. The reduction in exports of electricity accounts for another 2%.

TABLE 1
Carbon Dioxide Emissions Reduction Is 32% From Nuclear Power
(Percent)

Sector	Reduced Economic Activity	Conservation & Efficiency	Fuel Switching
Residential, Commercial, Industrial	8%	7% (price)	1% (oil)
Transportation	9%	6% (price) 2% (small cars)	1% (NGV)
Electric Utility	9%	20% (price) 2% (explicit conservation)	1% (Natural Gas) 2% (exports) 32% (Nuclear)
TOTAL	26%	37%	37%

Conservation and price effects are the second major source of carbon dioxide reductions. Conservation in the Residential, Commercial and Industrial sectors amounts to 9% of the total emissions reductions. The increase in efficiency of motor vehicles accounts for about 2% of emissions reductions while price effects, on the transportation demand for fuel, account for another 6%.

In the electric utility sector, an additional 20% of carbon dioxide reductions are associated with price effects. Provinces with the highest carbon content of electricity (i.e., Alberta, Saskatchewan and the Atlantic region) face particularly high prices for electricity and substantial price-induced changes. Consequently, these regions drastically cut back on the use of coal in electricity generation.

The electric utility sector actually accounts for two-thirds of the CO_2 emissions reduction. Conservation, interfuel substitution, and economic impacts broadly affect electricity consumption as well as utility fuel choice.

Most of the impact of the carbon tax scenario occurs because of discrete actions by large entities such as government and electric utilities. The scenario assumes that motor vehicle efficiency is monitored and fuel quality standards set by government. Nuclear switching by utilities is also assumed, since the carbon tax on coal would otherwise add several billion to annual utility operating costs. The cost of constructing new nuclear capacity is substantially above that of coal plants. Fuel costs however, are very small for nuclear plants—about $180 million for the 7200 megawatts in 2005—while the equivalent coal costs would be over 6 billion. The lifetime costs of nuclear plants (capital, fuel and other operating expenses) are anticipated to be less than those of coal plants in the extreme carbon tax scenario.

The government would have enormous amounts of additional revenue once carbon taxes are imposed. In the moderate case, this ranges from $13 billion in 1995 to $23 billion in current dollars by 2005. In the extreme case, the revenue gains range from $33 billion in 1995 to $177 billion in nominal dollars by 2005. The government is thus expected to fund broad-based conservation, substitution, and conversion, as well as part of the nuclear program. A major increase in government energy programs—over and above all of the past and existing involvement in energy—would be expected to accompany an extreme carbon tax. Government already has overwhelming control over electric utility supply capacity decisions. Already, provincially-owned electric utilities are promoting significant programs in electricity conservation.

Government program expenditures would include energy initiatives to help achieve CO_2 objectives. The cost of electric utility conservation programs are about $40 billion over the 1990-2005 period. Also, the cost of constructing 7200 megawatts of nuclear power is major. Additional expenditures would be required to fund Atomic Energy of Canada Ltd. and find a solution to nuclear waste disposal.

The huge government revenue increases in the extreme carbon tax scenario would have a pervasive impact on society. The massive tax increases—which are close to those in the extreme goods-and-services tax (GST) case, and stabilize CO_2 emissions at 1990 levels—lead to an enormous increase in the size of government, and induce radical changes in the relative price of fossil fuels.

Moreover, many of the decisions concerning energy use would be mandated by government. Electric utilities would face heavy taxes unless they switched to nuclear power. And consumers would face European-level prices for petroleum products.

The following discussion presents DRI/McGraw-Hill's analysis of the carbon tax scenarios in the order of their macroeconomic, regional/industrial, energy, and carbon dioxide impacts.

Policy Assumptions

The introduction of a carbon tax raises the price of coal, oil, natural gas and electricity by the following amounts:

Percent Difference from Base in Price in 2005*

	Coal	Oil	Natural Gas	Electricity
Moderate	70.5	16.7	15.1	8.4
Extreme	333	83.9	75.8	33.2

*The prices represent changes in aggregate national indices and are not directly comparable to the more specific prices referred to in the Energy Results section.

Economic Impacts

Moderate Case

(Percent difference from base, except as noted)

	1995	2000	2005
Real GDP	-1.8	0.1	-0.3
CPI Level	0.6	0.8	1.8
Exchange Rate (U.S. cents)	2.3	-0.3	-0.9
Interest Rates (percent)	1.0	0.0	0.1
Trade Balance ($billion)	3.3	0.2	-1.7
Business Nonres. Investment	-4.6	-2.3	3.1
Direct Revenue Impact ($billion)	13.0	17.2	23.3

- In the moderate case, the CPI initially increases by 0.8 percent in 1994; by the forecast horizon it is 1.8 percent above base case values. Interest rates and the dollar initially rise through the mid 1990s; subsequently rates drop back and the dollar slides below base values as our competitiveness is eroded.
- The level of real GDP is reduced by a maximum 1.8 percent in 1994 and 1995, before tapering off to -0.3 percent by 2005.
- The consumer is hardest hit throughout, dropping 1.7 percent below the base case by 2005. Capital spending is reduced until the late 1990s, when higher investment turns this positive. The nominal trade balance is initially boosted by the weak economy; subsequently this reverses as higher capital spending boost imports.

Extreme Case

(Percent difference from base, except as noted)

	1995	2000	2005
Real GDP	-1.9	-2.4	-0.4
CPI Level	2.0	6.4	10.1
Exchange Rate (U.S. cents)	0.4	1.8	-1.9
Interest Rates (percent)	0.1	2.0	1.3
Trade Balance ($billion)	2.9	2.5	-2.9
Business Nonres. Investment	-4.8	-2.2	3.7
Direct Revenue Impact ($billion)	32.6	100.0	176.6

- In the extreme case inflation is increased by 1 percent -2 percent per year, leaving the CPI with a cumulative increase of 10.1 percent by 2005. Interest rates are up by a similar amount, though; the Canadian dollar initially appreciates but later drops below base case values as a result of the erosion in our competitiveness and weaker trade balance.
- The surge in capital spending mitigates the impact on the economy after the year 2000; nevertheless, real GDP is reduced by a maximum 3.1 percent in 1999. Notably, we have assumed that the respending of revenues from the carbon tax helps support the capital spending program, which exceeds 1 percent of GDP at its peak.
- As in the moderate case, the consumer and housing are severely hit. In addition, the indirect effects of the weaker economy leave capital spending (despite the infusion of funds to support the nuclear program) in negative ground until 2004. The real trade balance is also reduced in virtually every year, culminating in a drop equivalent to 2.4 percent of GDP by 2005.

Regional and Industrial Impacts

The introduction of a carbon tax raises the price of coal, oil, natural gas, and electricity, causing a decline in demand for these commodities. The carbon tax scenarios result in a large negative impact on real output by the mining industry; national mining output declines a cumulative 10.6 percent in the extreme case relative to the base case, compared with a 6.6 percent decline in aggregate output. The declines in mining output for Canada increase steadily over the simulation horizon until the trough is reached at the turn of the century, with mining output down about 20 percent by the year 2000. Related industries suffer similarly severe declines in the extreme

scenario, with petroleum and coal refining down 9.1 percent and chemicals down 4.9 percent; both drops represent the largest negative impact of all scenarios.

Given the large relative weight of Alberta's mining industry, Alberta suffers nearly a 14 percent cumulative decline in mining output and an 8 percent decline in aggregate output in the extreme carbon tax scenario—the largest drop for any region in any of the scenarios. By the year 2000, real mining output in Alberta is down 31 percent (or $5.5 billion in real 1981 dollars). The large decline in output gives the province a 10.5 percent total decline in employment and a 4.5 percent total decline in real disposable income. This translates into dramatically higher unemployment rates, which average 10.4 percent in Alberta over the 16-year period, compared with 5.5 percent in the base case. The area's deteriorating economic environment results in an average annual out-migration of 11.5 thousand people in the extreme carbon tax scenario, compared with an average annual in-migration of 14.3 thousand people in the base case. In turn, this results in a cumulative 6.7 percent decline in population in Alberta relative to the base case, and a 24 percent drop in housing starts (compared with a 10 percent cumulative decline nationally).

TABLE 2
Cumulative Declines in Industrial Output and Employment for Severe Carbon Tax Case

% Decline (90-2005)	National	Alberta	Ontario
GNP at Factor Cost	6.6	8.1	6.8
Total Goods Output	7.4	9.7	7.1
Mining Output	10.6	13.9	6.5
Petroleum and Coal Output*	9.1	9.1	9.1
Chemicals Output	4.9	4.6	5.0
Transportation Equipment Output	6.3	5.6	6.5
Pulp and Paper Output	6.1	5.8	6.2
Housing Starts	9.8	23.5	18.4
Employment	0.6	10.5	0.6
Unemployment Rate**	0.6	4.9	0.1
Real Disposable Income	3.3	4.5	2.6

Cumulative Declines in Industrial Output and Employment for Moderate Carbon Tax Case

% Decline (90-2005)	National	Alberta	Ontario
GNP at Factor Cost	1.8	2.8	1.9
Total Goods Output	2.2	3.4	2.0
Mining Output	3.5	5.0	1.6
Petroleum and Coal Output	3.2	3.2	3.2
Chemicals Output	1.2	1.0	1.2
Transportaiton Equipment Output	0.6	0.2	0.7
Pulp and Paper Output	1.6	1.3	1.6
Housing Starts	3.0	16.8	5.7
Employment	0.2	3.7	-0.4
Unemployment Rate**	0.2	1.4	-0.3
Real Disposable Income	1.8	3.1	1.7

*Percent declines reflect relatively constant share of regional output in base case.
**Expressed as the average annual increase.

Energy Results

Energy demand is the only focus of CO_2 reduction. To achieve reductions in CO_2 emissions, either energy demand must be reduced or consumers induced to switch to fuel and power sources with lower carbon content.

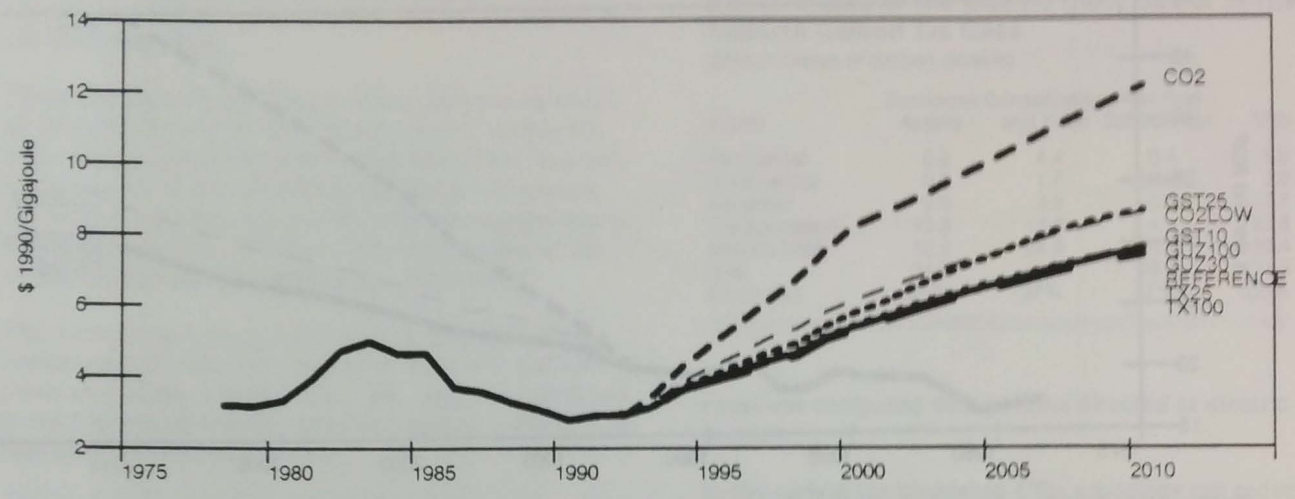
Fuel price changes would likely induce such switching. Energy prices are appreciably higher in the extreme carbon tax scenario. The tax of $381 ($200 real) per tonne of carbon translates into $7.59 per gigajoule of light fuel oil. Light fuel oil prices are increased by 45.7% from $17.47 per gigajoule in the Reference case to $25.46 in the Extreme Carbon Tax scenario. The tax on natural gas is $5.16 per gigajoule while that for coal ranges from $9.38 in Ontario to $10.56 in Saskatchewan. Coal is still cheaper than natural gas even after the differential in carbon taxes is applied to the purchase prices.

Coal prices would be different for each region of Canada, based on the carbon content of the coal used and the subsequent tax applied. Ontario uses imported coal with an average CO_2 content of 90.23 tonnes per terajoule. The price of imported coal includes transportation and is about three times the minemouth price of western coal. Alberta uses subbituminous coal with a CO_2 content of 94.2 tonnes per terajoule. The carbon tax on Alberta coal would thus be greater than on Ontario coal. Saskatchewan uses lignite with a CO_2 content of 101.68 tonnes per terajoule. Most of the western coal is used directly at the minemouth, thus avoiding transportation costs and achieving a lower overall purchase price.

TABLE 3
Energy Price Increases Are Dominated by the Carbon Tax
($ Per Gigajoule In 2005)

Fuel	CO2 Content (Tonnes/ Terajoule)	Carbon Tax	Reference Case	Extreme Carbon Tax
LFO	73.11	7.59	17.47	25.46
HFO	80.65	8.38	12.06	20.11
Industrial Natural Gas				
Canada	49.46	5.16	12.85	19.94
Ontario	49.46	5.16	13.87	21.92
Electric Utility Coal				
Alberta	94.2	9.79	1.74	11.53
Sask.	101.68	10.56	1.85	12.42
Ontario	90.23	9.38	5.89	15.33
Canada			3.61	13.47

CHART 1
Industrial Gas Prices Rise With Carbon Tax



TX25 = Motor Fuel Tax Moderate
TX100 = Motor Fuel Tax Extreme
GUZ30 = Gas Guzzler Moderate
GUZ100 = Gas Guzzler Extreme
CO2LOW = Carbon Tax Moderate
CO2 = Carbon Tax Extreme
GST10 = GST Moderate
GST25 = GST Extreme

To reduce energy demand, the carbon tax case reduces economic activity. Energy demand in total is the second lowest in the carbon tax extreme case. The electricity demand and electric utility fuel decreases in the GST extreme case outweigh the carbon tax on total energy demand. If only sectoral energy demand is counted, the carbon tax reduces energy demand the most. The carbon tax has a strong negative effect on demand in all sectors.

The carbon tax and associated reduction in economic activity causes energy demand to decrease by about 9%

CHART 2
Coal Prices Are Highest for Carbon Taxes

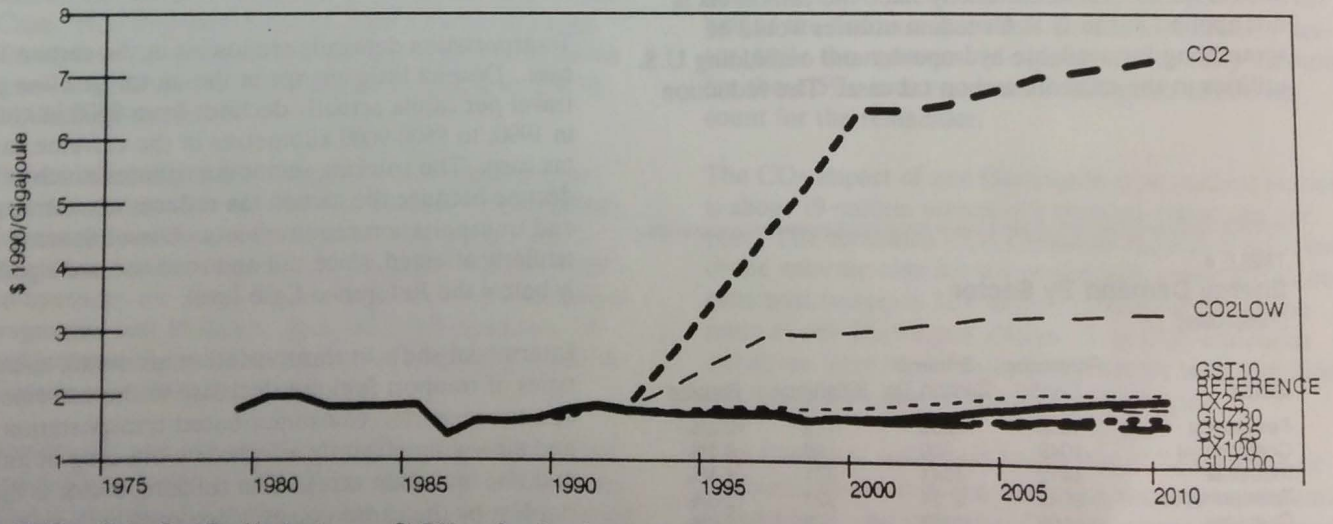


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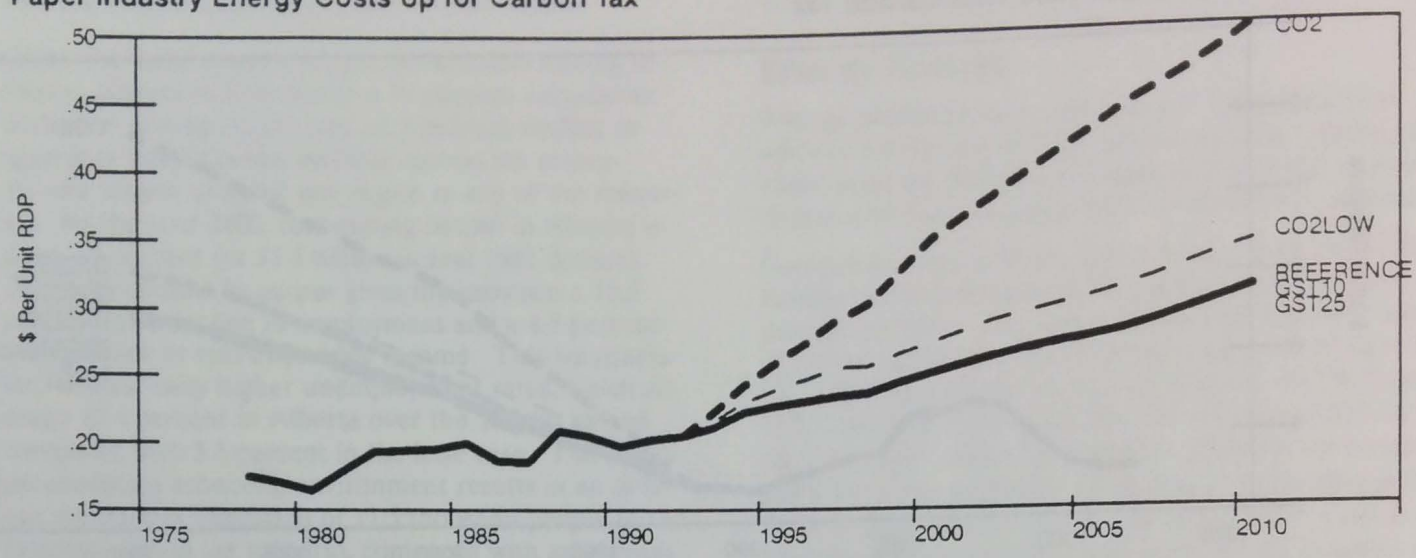
CHART 3
Paper Industry Energy Costs Up for Carbon Tax



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GST10 = GST Moderate
GST25 = GST Extreme

by 2005. Consumer sectors are hit the hardest as both Residential demands and Transportation demands decline by over 12%.

Electric utility fuel demand represents primary energy and includes both domestic and foreign consumption of electricity. Domestic electricity demand is also counted within the sector totals. Exports of electricity offer a direct way of reducing carbon dioxide emissions without impacting domestic demand. The carbon tax case has almost no exports of electricity since the carbon tax is not applied in the U.S. Canadian utilities would be scrambling for available hydropower and outbidding U.S. utilities in the extreme carbon tax case. The reduction in electricity exports reduces primary energy demand by about 1%.

The energy demand decreases are also noticeable for the effect on energy production. Heavy crude oil production declines by 500 mbd compared with the Reference Case. There is no additional investment in crude bitumen or oil sands facilities. Nuclear power is the principal winner in this scenario, with over 7200 megawatts of new power plants online by 2005.

Transportation demands are lowest in the carbon tax case. Despite little change in the motor gasoline price, travel per capita actually declines from 9500 kilometres in 1990, to 8500-9000 kilometres in the extreme carbon tax case. The trucking sector contributes much of the decline because the carbon tax reduces economic activity and transportation requirements. Diesel demand is particularly affected, since rail and road use are significantly below the Reference Case level.

Intermodal shifts in transportation are small, since all types of tranport fuel use decrease in the extreme carbon tax scenario. Consumer-based transportation—road and air—is significantly affected by the drop in income and rise in carbon taxes. The trucking sector is hit the hardest by the carbon taxes, since carbon taxes have a more negative effect on goods production (and hence distribution services) than on the total economy.

TABLE 4
Energy Demand By Sector
(Petajoules)

Sector	Reference Case	Extreme Carbon Tax	Difference	Percent
Residential	1408	1236	172	12.2%
Commercial	1049	950	99	9.1%
Industrial	4412	4041	371	8.4%
Transportation	2545	2224	321	12.6%
Own Use	1109	1087	22	2.0%
Total	10523	9538	985	9.4%

Electric utilities incur the largest fuel cost increases in the carbon tax case despite a massive shift to primary electricity. Coal prices in Western Canada are up to eight times as high in the extreme carbon tax case as in the reference case.

The paper industry in Ontario would face energy costs of up to 50 percent of RDP in the extreme carbon tax case. Other energy-intensive industries would face similar increases. Many industrial establishments provide for part of fuel requirements by their own generation or use of waste wood. However, incremental production would depend upon purchased fuel and power.

The increase in energy costs per unit of output for the Ontario paper industry is typical of cost increases for other provinces and industries. The carbon tax scenario is not friendly to energy-intensive industry, historically a strength of Canada's economy.

Carbon Dioxide Results

It is clear that CO_2 emissions can be reduced from the Reference Case levels. But for most scenarios there are still increases in CO_2 emissions. Indeed, the goal of flat emissions below 500 million tonnes is only achieved in the extreme carbon tax case. CO_2 emissions reductions are obtained at a huge reduction in GDP and as a consequence of a massive shift to nuclear fuel, with an overwhelming cost to energy-intensive industry.

The only major lever that Canada has to lower CO_2 emissions is electric utility fuel choice. By 2005, utility emissions range from 84 million tonnes in the extreme carbon tax case to 170 million tonnes in the Reference Case. No other sector has as great a potential swing. Transportation emissions range from 150 to 174 million tonnes, while the industrial sector ranges from 195 to 209 million tonnes.

Industrial energy demand and CO_2 emissions are targeted in the carbon tax cases with severe consequences for energy-intensive industry such as mining, paper, chemicals and primary metals. Canada's international competitors are often Third World countries with lower wages and less stringent environmental standards. A self-imposed increase in the cost of producing goods in Canada is unlikely to be matched.

Residential and commercial CO_2 emissions are modest and account for only 10% of Reference Case emissions. This is because the electric utility emissions are credited to the utility sector. Policies directed at the consuming sectors would have a negligible effect on total CO_2 emissions compared with policies directed at electric utilities.

TABLE 5
Carbon Dioxide Emissions Reduction Are Concentrated In The Electric Utility Sector In The Extreme Carbon Tax Case
(Million tonnes of carbon dioxide)

Sector	Economic Activity	Conservation and Price	Inter Fuel Substitution	Total
Residential	0.2	4.4	0.4	5.0
Commercial	0.6	1.7	0.5	2.8
Industrial	9.3	3.8	0.6	13.7
Transportation	12.2	10.5	1.4	23.9
Electric Utility	12.2	28.5	45.7	86.4
Total	34.5	48.9	48.6	131.8
Share (%)	26%	37%	37%	100%

In the carbon tax scenarios, CO_2 emissions are reduced by 8% for the $50 tax, and by 21% for the $200 tax by 2005. While these reductions are larger than those generated in the other tax scenarios, they are also more concentrated. The electric utility sector accounts for 67% of CO_2 emissions reduction in the moderate case, and 65% in the extreme case. The transportation sector accounts for about 20% of the total CO_2 reduction, and the other three sectors-residential, commercial, and industrial-represent only a very small share.

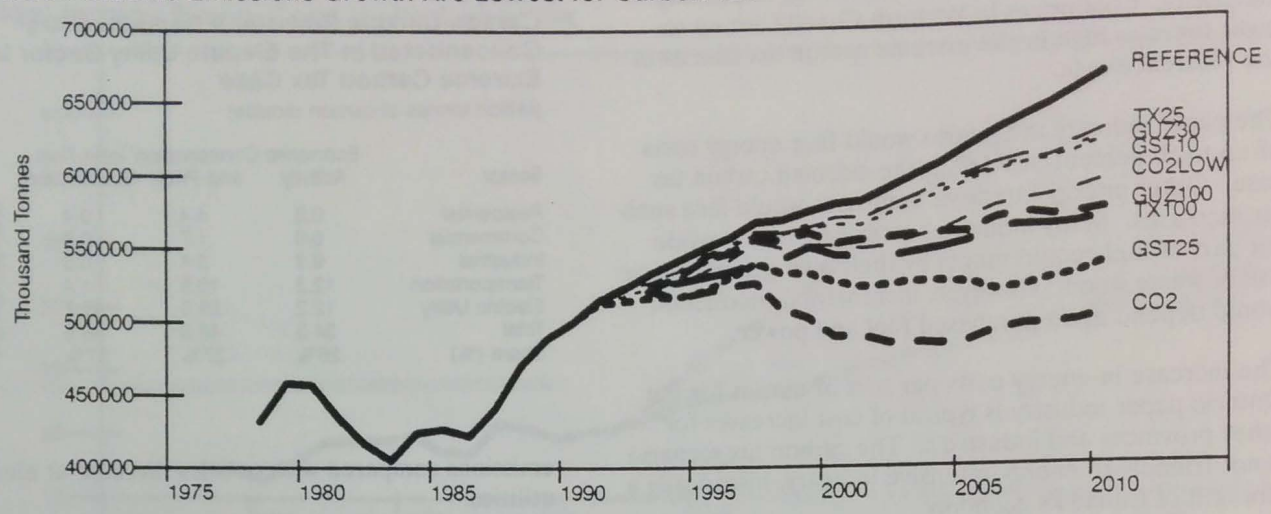
Carbon dioxide emissions are reduced by 21.4% in the extreme carbon tax case. Reductions by sector are about in line with the reductions in energy demand. The electric utility sector shows a 50.7% decrease in carbon dioxide emissions compared with an 8.8% reduction in fuel use. The switch from coal to nuclear fuel accounts for half of the decrease in carbon dioxide in the utility sector, while the reduction in exports of electricity accounts for about 5%, and conservation and price effects account for the remainder.

The CO_2 impact of one Darlington-type nuclear station is about 19 million tonnes of emissions reduction per year. The combined CO_2 emissions reduction achieved in the extreme case for the residential, commercial, and industrial sectors is 21.4 million tonnes, or about the same as one Darlington station. The CO_2 emissions reduction from the transportation sector is 23.9 million tonnes, again equal to about one Darlington.

The moderate case again shows that CO_2 emission reductions are small in the nonutility sectors: residential, commercial, and industrial CO_2 emissions decline by 4.3 million tonnes per year and transportation emissions decline by 8 million tonnes. In contrast, electric utili-

CHART 4

Carbon Dioxide Emissions Growth Are Lowest for Carbon Tax



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GUZ100 = Gas Guzzler Extreme
CO2LOW = Carbon Tax Moderate
CO2 = Carbon Tax Extreme
GST10 = GST Moderate
GST25 = GST Extreme

ties, which account for two-thirds of the impact, reduce emissions by 32 million tonnes.

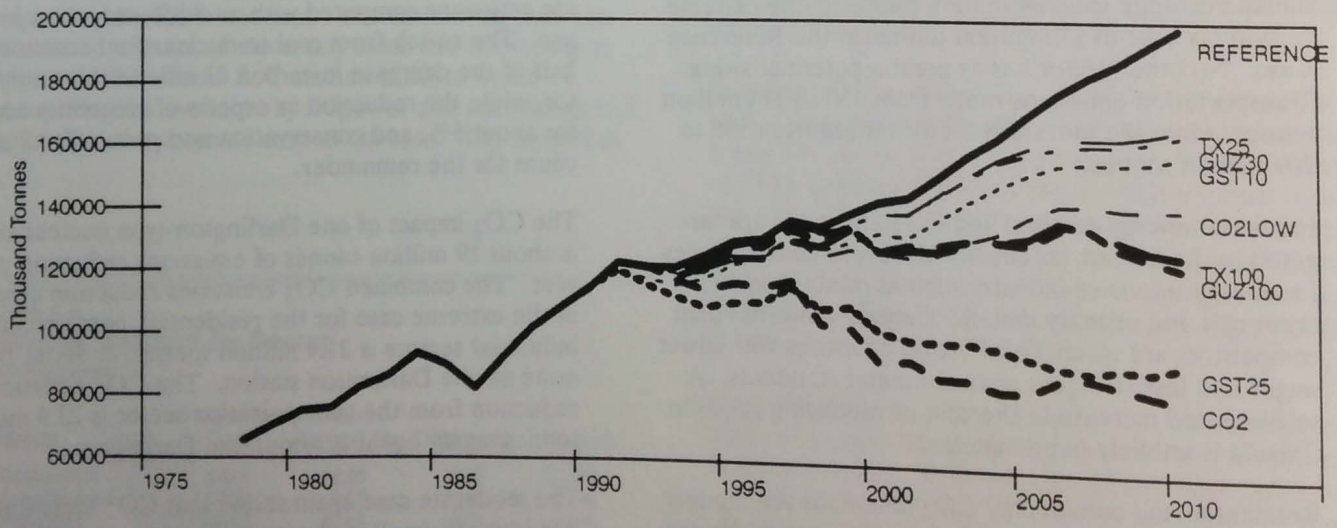
Thus, the carbon tax is primarily a tax on coal and electric utilities. Most of the economic impact, however, is borne by other sectors.

Comparison of Results

A comparison of the results of the carbon tax scenarios with those of the GST, motor fuels tax, and gas guzzler tax scenarios can be found in the Appendix.

CHART 5

Utility CO_2 Emissions Are Lowest for Carbon Tax



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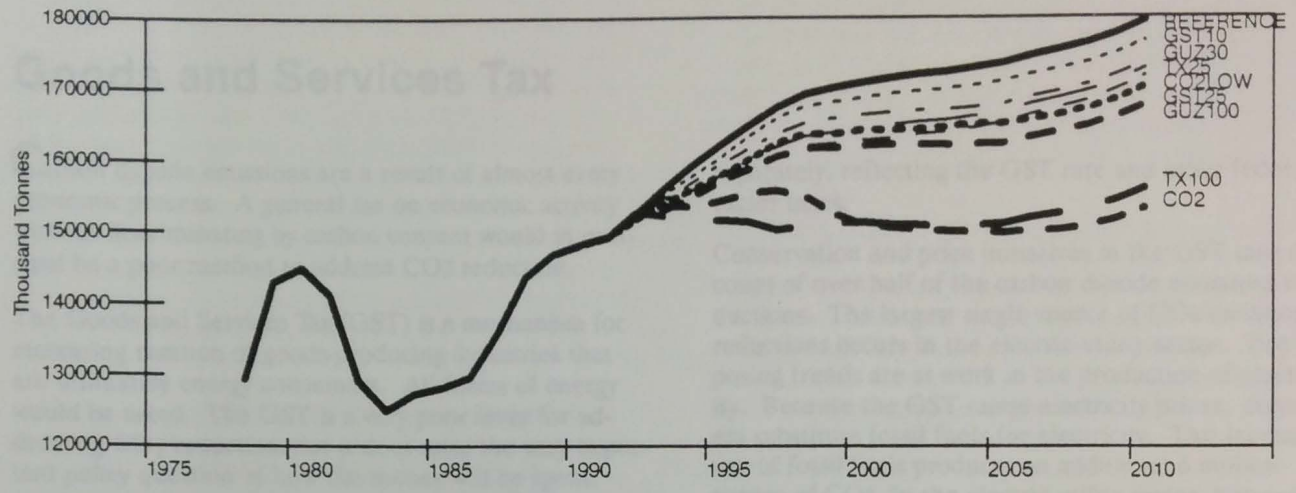
GST10 = GST Moderate
GST25 = GST Extreme

CHART 6
Transportation CO_2 Emissions



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Goods and Services Tax

Carbon dioxide emissions are a result of almost every economic process. A general tax on economic activity without discriminating by carbon content would in principal be a poor method to address CO_2 reduction.

The Goods and Services Tax (GST) is a mechanism for increasing taxation of goods-producing industries that are ultimately energy consumers. All forms of energy would be taxed. The GST is a very poor lever for addressing CO_2 reduction, but it does raise the very important policy question of how the money will be spent.

Government taxes in order to spend. Increases in the GST imply an enormous increase in the capability of government to intervene in environmental matters. Tax revenue could be used to plant trees, phase out chloroflurocarbons (CFCs), and support research and development of low emission technologies.

Government could also invest in efficient energy use. Conservation and demand management are already active areas for government policies. Electric utilities are undertaking large-scale demand management and passing the costs along to rate payers. Tax revenue could also be used for lowering income tax rates or reducing the deficit.

The GST applies to all forms of energy electricity, coal, petroleum products and natural gas. Not all petroleum products are directly included. Motor fuels are taxed separately, reflecting the GST rate and other federal excise taxes.

Conservation and price initiatives in the GST case account of over half of the carbon dioxide emissions reductions. The largest single source of CO_2 emissions reductions occurs in the electric utility sector. Two opposing trends are at work in the production of electricity. Because the GST raises electricity prices, consumers substitute fossil fuels for electricity. This increased use of fossil fuels produces an additional 6 million tonnes of CO_2. In the electric utility sector, however, the substitution of nuclear for coal accounts for nearly one third of total CO_2 reduction. This reduction more than offsets the additional CO_2 emissions produced by increased fossil-fuel use in the consumer sector. Reduced economic activity, although significant, accounts for only 18% of the total CO_2 emissions reductions.

Personal income is over 2.6% lower in real terms for the 1990 to 2005 period as a consequence of the tax. In the extreme scenario, about 16.9 million tonnes of carbon dioxide reduction is attributed to reduced economic activity, which amounts to a 3% reduction in total carbon dioxide emissions and accounts for about one fifth of the reduction in carbon dioxide.

Policy Assumptions

Increases in the GST raise government tax revenues by nearly $3.5 billion per 1 percent. Increases in the GST are

TABLE 1
Increased Use of Nuclear Power Explains 31% of Carbon Dioxide Reduction, While Large Electric Price Increases Cause Switching To CO_2-Producing Oil and Gas
(Percent)

Sector	Reduced Economic Activity	Conservation & Efficiency	Fuel Switching
Residential, Commercial, Industrial	7%	8%	(6%) (price)
Transportation	2%	5%	2% (NGV)
Electric Utility	9%	42% (price)	31% (Nuclear)
TOTAL	18%	55%	27%

phased in starting with 1 percent per year in the moderate case and 2 percent per year in the extreme case.

	Moderate Case (Percent)	Extreme Case
1991	7	7
1992	8	9
1993	9	11
1994	10	13
1995	10	15
1996-2005	10	increases by 1 percent each year to reach 25 percent by 2005

Economic Impacts

Moderate Case

(Percent difference from base, except as noted)

	1995	2000	2005
Real GDP	-0.9	-0.0	0.1
CPI Level	1.4	1.5	1.4
Interest Rates (percent)	0.0	0.0	0.1
Exchange Rate (U.S. Cents)	1.0	0.0	-0.2
Trade Balance ($billion)	0.9	-1.8	-6.4
Business Nonres. Investment	-1.4	2.6	4.0
Direct Revenue Impact ($billion)	12.1	18.5	28.0

- In the moderate case, inflation increases by roughly 0.5 percent from 1992 to 1994; subsequently it returns to base values, since there are no additional increases in the GST.
- Real GDP growth drops by roughly 0.4 percent from 1992 to 1994; from 1996-2005 the level of real GDP is virtually equal to the base case.
- Higher investment and government expenditure (due to respending) offsets weaker consumer and housing sectors, and induces the deterioration in the trade balance.

Extreme Case

(Percent difference from base, except as noted)

	1995	2000	2005
Real GDP	-2.0	-0.3	-0.4
CPI Level	4.4	7.7	12.5
Exchange Rate (U.S. Cents)	3.7	2.5	0.6
Interest Rates (1 percent)	1.5	1.5	1.1
Trade Balance ($billion)	3.0	-7.4	-21.0
Business Nonres. Investment	-2.1	+6.3	+8.0
Direct Revenue Impact ($billion)	33.5	86.1	191.4

- In the extreme case, inflation rises by 1.3 percent each year to 1995, and by an average 0.8 percent thereafter. The CPI is 12.5 percent higher than in the base case by 2005.
- Real growth drops by an average 0.8 percent in each of the first three years, and remains below base values to 2005.
- The higher interest rates throughout the period strengthen the dollar, which helps moderate the inflation impact. However,the lower import costs help boost investment (particularly in machinery and equipment, but this also leads to a sharper drop in the trade balance. As in the moderate case, consumer spending is reduced by more than GDP (despite a reduction in the personal savings rate) as is residential investment.

Regional and Industrial Impacts

The negative impact of a higher GST is spread relatively evenly across industries and regions, reflecting the broader nature of the tax compared to the other policies. Real aggregate output is down a cumulative 4.5

TABLE 2

Cumulative Declines in Industrial Output and Employment for Severe GST Case

% Decline (90-2005)	National	Alberta	Ontario
GNP at Factor Cost	4.5	4.8	4.7
Total Goods Output	6.3	5.7	6.8
Mining Output	5.6	5.8	5.5
Petroleum and Coal Output*	6.2	6.2	6.2
Chemicals Output	2.9	2.5	3.0
Transportation Equipment Output	3.2	2.6	3.4
Pulp and Paper Output	7.1	6.6	7.1
Housing Starts	16.1	26.8	23.0
Employment	0.8	3.7	2.1
Unemployment Rate**	0.7	1.9	0.9
Real Disposable Income	2.6	7.0	1.4

Cumulative Declines in Industrial Output and Employment for Moderate GST Case

% Decline (90-2005)	National	Alberta	Ontario
GNP at Factor Cost	1.7	1.6	1.8
Total Goods Output	2.1	1.7	2.4
Mining Output	1.6	1.7	1.5
Petroleum and Coal Output	2.2	2.2	2.2
Chemicals Output	1.2	1.0	1.3
Transportation Equipment Output	0.6	0.4	0.7
Pulp and Paper Output	2.0	1.7	2.0
Housing Starts	4.4	6.6	6.2
Employment	0.2	0.7	0.6
Unemployment Rate**	0.2	0.4	0.4
Real Disposable Income	1.1	1.7	0.9

*Percent declines reflect relatively constant share of regional output in base case.
**Expressed as the average annual increase.

percent relative to the base case over the 16-year period of the simulation.

Ontario suffers one of the greatest declines, particularly in the extreme scenario, with aggregate output down 4.7 percent. This is the result of a cumulative 7.2 percent drop in national manufacturing output, with Ontario's relatively large manufacturing sector bearing the lion's share of that decline. The higher unemployment rate and lower disposable income growth of these scenarios result in a dramatic decrease in migration into Ontario. As a result, population in Ontario is down in both GST scenarios by a cumulative 0.2 percent and 0.8 percent in the moderate and extreme cases, respectively. As a result, the province suffers a striking 23 percent reduction in housing starts (approximately 225 thousand units) over the 16-year period.

Although the level declines in population and housing starts are smaller in Manitoba than in Ontario, the percentage declines are more significant; Manitoba's population and housing starts drop a cumulative 4.5 percent and 34 percent, respectively, relative to the base case. This reflects the higher sensitivity of migration in Manitoba to the economic environment: a smaller deterioration in disposable income growth and unemployment rates will cause a larger relative reduction in migration in Manitoba than in Ontario.

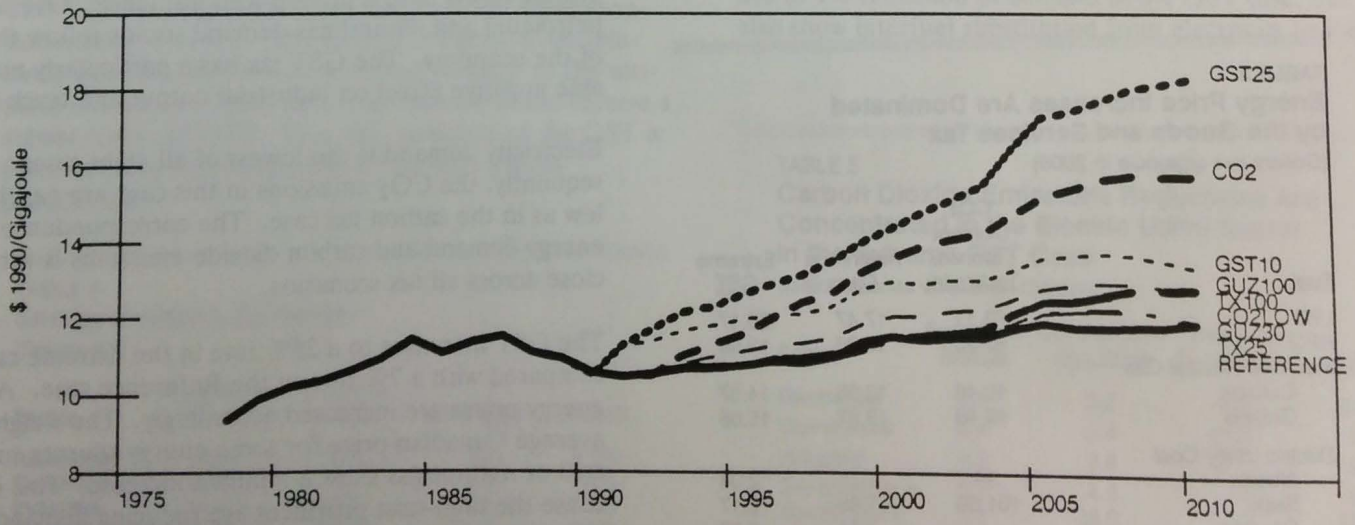
Finally, it is also noteworthy that although aggregate real output is down in all regions for all scenarios, some regions will bear a relatively smaller burden of the impact. As a result, some provinces will appear relatively more attractive and will therefore draw a greater proportion of international and inter-provincial migrants. Since none of these scenarios affect the total number of births or deaths or total international immigration, then some provinces will necessarily experience absolute increases in the level of migration and population. These gains in turn will lead to increases in housing starts and some other essential services, mitigating some of the negative impact of the increased tax in any of the scenarios.

The impact of the extreme GST scenario on Quebec is a good example of this phenomenon. Aggregate output in Quebec is down a cumulative 3.5 percent relative to a national decline of 4.5 percent. Unemployment rates and disposable income growth deteriorate less in Quebec than elsewhere in the nation. As a result, Quebec enjoys a stronger rate of migration than in the base case, resulting in a cumulative 2.6 percent increase in population and a 7.4 percent (or 41 thousand units) improvement in housing starts.

Energy Results

The GST causes a pronounced shift from electricity to other fuels. The electric utility sector incurs the major impacts from the GST. The tax affects prices in three ways: a direct increase; a lowering of demand from lower economic activity; and much higher costs related to adding new nuclear stations. Electricity demand is down nearly 25 percent in the extreme case compared with the

CHART 1
Electricity Prices Are Highest for GST



TX25 = Motor Fuel Tax Moderate
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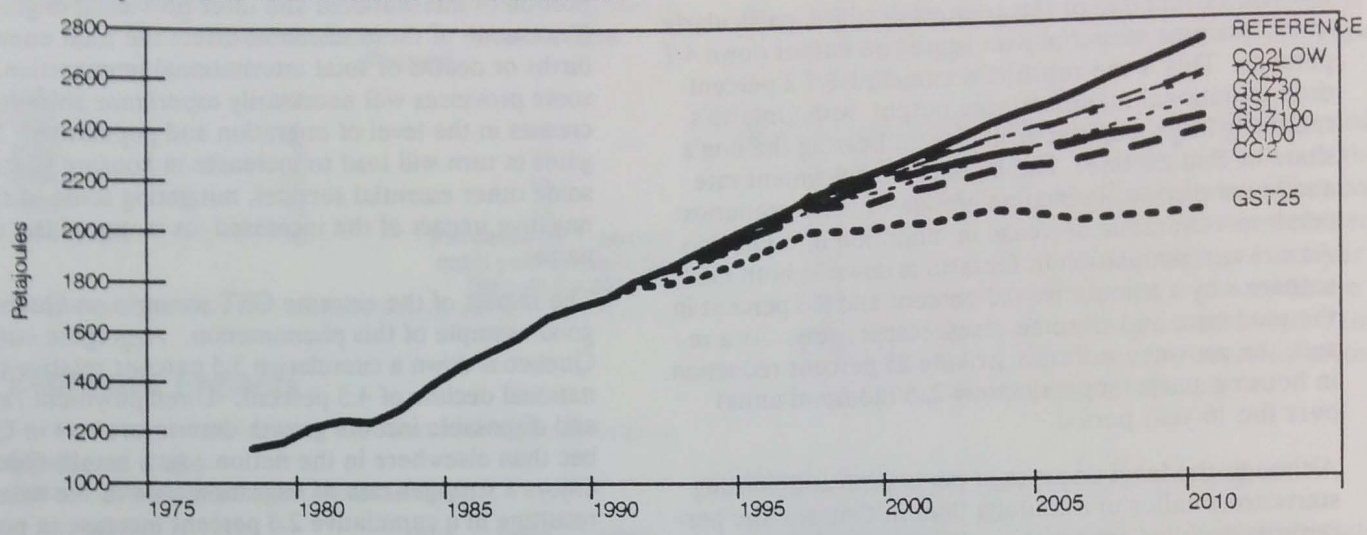
CO2LOW = Carbon Tax Moderate
CO2 = Carbon Tax Extreme
GST10 = GST Moderate
GST25 = GST Extreme

CHART 2
Electricity Demand Is Lowest for 25 Percent GST



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Reference Case. Electricity prices are up substantially, much more than just a 25 percent increase associated with the GST.

There is more inflation in general in this scenario. Inflation originates in all goods and services covered by the tax rather than in oil and gas. In fact, real oil and gas prices are actually lower in the GST cases than in the Reference Case. This encourages a substantial substitution of oil and gas for electricity in the residential sector and further contributes to lowering electricity demand.

The GST case also has perverse effects on carbon dioxide emissions, small car sales, and petroleum demand. Residential and Commercial CO_2 emissions are higher in the GST cases because of the substitution of oil and gas for electricity. Small cars have no particular advantage over large cars, since motor fuel tax changes are minimal and other factors such as unemployment and income levels have a pronounced influence. Overall petroleum and natural gas demand trends follow those of the economy. The GST tax has a particularly noticeable negative effect on industrial output and truck fuel.

Electricity demand is the lowest of all eight cases. Consequently, the CO_2 emissions in this case are nearly as low as in the carbon tax case. The correspondence of energy demand and carbon dioxide emissions is very close across all tax scenarios.

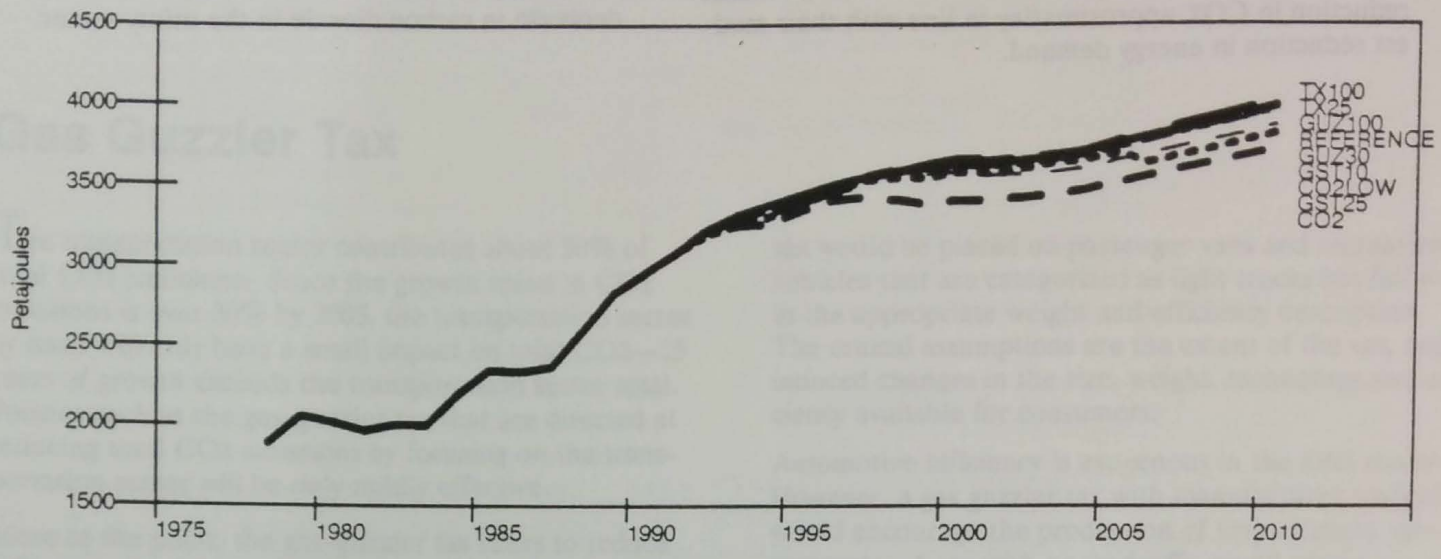
The GST increases to a 25% rate in the extreme case, compared with a 7% rate in the Reference case. All energy prices are increased accordingly. The weighted average Canadian price for some energy sources such as coal or natural gas show a minimal increase. This is because the high-cost provinces are reducing demand much faster than the low-cost provinces. The high GST increases the price of Alberta coal by only $0.30 per gigajoule. The price increases for natural gas and petro-

TABLE 3
Energy Price Increases Are Dominated by the Goods and Services Tax
(Dollars per gigajoule in 2005)

Fuel	CO_2 Content (Tonnes/ Terajoule)	Reference Case	Extreme GST
LFO	73.11	17.47	20.17
HFO	80.65	12.06	13.99
Industrial Natural Gas			
Canada	49.46	12.85	14.57
Ontario	49.46	13.87	15.66
Electric Utility Coal			
Alberta	94.2	1.74	2.04
Sask.	101.68	1.85	2.17
Canada		3.61	3.27
Electricity		23.33	33.96

CHART 3

Natural Gas Demand Is Lowest for Carbon Tax and GST



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leum products run to several dollars per gigajoule, while those for electricity amount to even more.

Energy Demand

The carbon tax and associated reduction in economic activity decreases energy demand by about 7% by 2005. The residential and commercial sectors, which are highly dependent upon electricity, are hit the hardest by the extre me GST. Energy demand declines by 8% to 9% in these two sectors, while CO_2 emissions actually increase.

The GST moderately affects industrial and transportation energy demand. The GST is designed to be relatively neutral, and as such is passed through to the ultimate consumer. Also, industrial exports would receive a rebate from the GST. Thus the incidence of the GST is focused more on consuming sectors and less on production.

TABLE 4

Energy Demand By Sector

(Petajoules)

Sector	Reference Case	Extreme GST	Difference	Percent
Residential	1408	1279	129	9.2%
Commercial	1049	967	82	7.8%
Industrial	4412	4020	392	8.9%
Transportation	2545	2442	103	4.0%
Own Use	1109	1071	38	3.4%
Total	10523	9779	742	7.0%

Intermodal shifts in transportation are small since there are no significant relative price effects on the transportation sector. All petroleum product prices are increased by about the same amount. Consumer based transportation—road and air—are affected by the drop in income and rise in total taxes.

Carbon Dioxide Results

Carbon dioxide emissions are reduced by 15% in the extreme GST scenario, compared with the Reference case. The residential and commercial sectors show an 8% to 9% reduction in demand in the GST case, but also show interfuel substitution from electricity to fossil

TABLE 5

Carbon Dioxide Emissions Reductions Are Concentrated in the Electric Utility Sector in the Extreme GST Case

(Million tonnes of carbon dioxide)

Sector	Economic Activity	Conservation And Price	Inter Fuel Substitution	Total
Residential	0.1	2.2	(4.5)	(2.2)
Commercial	0.4	1.4	(1.0)	0.8
Industrial	6.2	3.8	(0.7)	9.3
Transportation	2.1	4.9	1.4	8.4
Electric Utility	8.1	38.9	28.9	75.9
Total	16.9	51.2	24.1	92.1
Share (%)	18%	55%	27%	100%

fuels. Thus the CO_2 emissions in these sectors actually increase.

The industrial and transportation sectors show a modest reduction in CO_2, approximatley in line with their modest reduction in energy demand.

Reduced electricity demand accounts for over half of the decrease in carbon dioxide emissions. The switch from coal to nuclear fuel accounts for about one third of the decrease in carbon dioxide in the utility sector.

Gas Guzzler Tax

The transportation sector contributes about 30% of total CO_2 emissions. Since the growth trend in CO_2 emissions is over 30% by 2005, the transportation sector by itself will only have a small impact on total CO_2—15 years of growth exceeds the transportation sector total. Policies such as the gas-guzzler tax that are directed at reducing total CO_2 emissions by focusing on the transportation sector will be only mildly effective.

More to the point, the gas-guzzler tax seeks to reduce CO_2 emissions by penalizing large, fuel-thirsty vehicles. But motor gasoline and road diesel represent only 20% of total energy. So downsizing motor vehicles can, at best, only partially reduce CO_2 emissions from energy.

The U.S. proposed a gas guzzler tax in 1978 that would have taxed cars achieving less than 12 miles per gallon at a rate of up to $2200. Highly efficient cars for 1978, 25 mpg qualifies as highly efficient, escaped the tax. Rather than imposing this tax, the U.S. relied upon the Corporate Average Fuel Efficiency Standards (CAFE) replete with tradeoffs and exemptions. The success of the program is apparent in that todays gas guzzlers compare favorably with yesterdays highly efficient cars.

For Canada, a gas guzzler tax poses a direct challenge to the automobile industry. North American vehicles contribute less than 70 percent of new car sales. Imports and transplants now account for nearly half of the new car market in Canada. Most North American vehicles would incur the gas guzzler tax, while imports and some transplants would not. Thus the transportation equipment industry would be significantly shocked by a gas guzzler tax.

Canadian consumers have shown tremendous ability to switch car sizes as evidenced by the Quebec experience in the past two decades. During the 1970s, over half of Quebec car were for large-size cars. After the doubling of the motor gasoline tax, to 40 percent of pump price, Quebec consumers switched almost completely to small cars. Thus a gas guzzler tax would very likely be effective in switching consumers to smaller and more efficient vehicles.

The gas guzzler tax would create an artificial price differential between large and small cars. Presumably, the tax would be placed on passenger vans and recreational vehicles that are categorized as light trucks but fall within the appropriate weight and efficiency description. The critical assumptions are the extent of the tax, and induced changes in the size, weight, technology and efficiency available for consumers.

Automotive efficiency is exogenous in the DRI model. However, a gas guzzler tax with manufacturer tradeoffs would encourage the production of very efficient subcompacts. A tax with no tradeoffs would encourage production of a uniform fleet of small, efficient cars.

The $2200 tax on the largest cars that the U.S. considered back in 1978 would translate into a tax range of around $5000 in 1990 Canadian dollars. The moderate case uses a tax of $5000 indexed to inflation. Also, there is an annual registration fee for large cars. In the moderate case this is assumed to be $500 per year. The extreme case assumes taxes of $20,000 to purchase a large car and annual registration fees of $2,000 per year with the taxes indexed to inflation.

Consumers can avoid the tax by purchasing small cars and by retiring large cars. Consequently, the tax revenue is proportionately smaller as the tax increases. In fact, most of the tax is collected from light trucks and existing vehicles.

Since carbon dioxide emissions are affected mostly by the switch from coal to nuclear power in electric generation, even the extreme gas-guzzler tax explains only a small share of overall CO_2 emissions reductions. Personal income under this scenario is about 1.5% lower for the 1990 to 2005 period. In the extreme gas guzzler tax scenario, about 12.4 million tonnes of carbon dioxide reduction is attributed to reduced economic activity, which amounts to 2.4% of total carbon dioxide emissions and accounts for a little more than one-fifth of the reduction in carbon dioxide. Interfuel substitution accounts for half of total carbon dioxide emissions reduction.

Unlike the carbon tax cases, there is no price incentive to switch fuels or conserve other than in the automotive sector. The gas guzzler tax does cause a major shift in car size. Sales of large cars are greatly diminished . The Transportation sector reduces CO_2 emissions by

TABLE 1
50% of Carbon Dioxide Emissions Reduction Comes From Nuclear Power
(Percent)

Sector	Reduced Economic Activity	Conservation & Efficiency	Fuel Switching
Residential, Commercial, Industrial	8%	3%	0%
Transportation	7%	10%	2%
Electric Utility	7%	13%	50%
TOTAL	22%	26%	52%

only 11.2 million tonnes by 2005, hardly noticeable against trend growth in emissions.

The results of the extreme gas guzzler tax case suggest that, in the switch from coal to nuclear fuel (4950 megawatts increase in nuclear), accounts for 50% of the total reduction in carbon dioxide.

The residential, commercial and industrial sectors contribute almost nothing to CO_2 emissions reductions. Without a change in energy prices or a major conservation initiative beyond that in the Reference case, there is no cause for CO_2 reductions.

Policy Assumptions

The tax on gas guzzlers and higher registration fees has the effect of raising purchase and ownership costs, leading to the following impacts on sales:

	Percent Change in Car Ownership Costs		Car Sales	
	1993	2005	1994	2005
Moderate	14	8.3	-8.4	-2.8
Extreme	25	14.0	-15.3	-5.3

Economic Impacts

Moderate Case
(Percent difference from base, except as noted)

	1995	2000	2005
Real GDP	-0.5	-0.2	-0.6
CPI Level	0.6	0.3	0.4
Exchange Rate (U.S. cents)	0.4	0.3	-0.2
Interest Rates (percent)	0.0	0.0	0.0
Trade Balance ($billion)	4.0	4.9	1.5
Business Nonres. Investment	-3.2	-1.0	0.7
Direct Revenue Impact ($billion)	5.9	7.2	8.6

- In the moderate case, the peak impact on the price level is 0.9 percent in 1993, which then fades to 0.3 percent by 2005. The weight of these costs in the CPI is 5.4 percent. Since motor vehicles represent approximately 15 percent of investment in machinery and equipment, this component was also adjusted to reflect the higher cost.
- The percentage decrease in sales is roughly 0.3 to 0.6 as large as the increase in costs; a great deal of the adjustment is realized by increased purchases of smaller cars. Since Canada tends to produce larger cars, our auto industry is particularly hard hit, causing relatively sizeable drops in our economy of up to 0.9 percent (1994).
- Consumption and investment are significantly weaker, and our reduced competitiveness also lowers our exports. The domestic weakness leads to an even larger drop in imports (even after allowing for the increased need to import smaller cars), and the trade balance shows a moderate improvement.

Extreme Case
(Percent difference from base, except as noted)

	1995	2000	2005
Real GDP	-1.9	-0.7	-0.9
CPI Level	1.1	0.6	0.4
Exchange Rate (U.S. cents)	0.7	0.5	-0.3
Interest Rates (percent)	0.0	0.0	0.0
Trade Balance ($billion)	7.1	7.6	3.3
Business Nonres. Investment	-5.8	-2.5	1.5
Direct Revenue Impact ($billion)	10.5	12.5	14.4

- In the extreme case, the CPI rises by a maximum 1.7 percent in 1993, eventually diminishing to 0.3 percent. This elicits an equivalent rise in interest rates during 1993.
- Real GDP growth deteriorates by a substantial 1.3 percent in 1993, and a further 0.2 percent in 1994. The effect on GDP is consistently negative, with the consumer bearing the largest share of the burden.
- As in the moderate case, domestic demand and exports are weaker, but the trade balance ekes out a modest gain due to the drop in imports. Again, the drop in imports would have been more severe were it not for the switch to non-Canadian produced smaller cars.

Regional and Industrial Impacts

The tax on gas guzzlers and higher registration fees lead to a decline in car sales. The targetted nature of the

two gas guzzler scenarios result in the third and fourth largest declines in transportation equipment output of the eight scenarios, although these two scenarios result in only moderate declines in aggregate output.

The extreme gas guzzler tax scenario results in a cumulative 2.7 percent decline in manufacturing output, with nearly 60 percent of that drop occurring in Ontario's manufacturing sector, which suffers a total 2.9 percent decline that is seen most significantly in both the transportation equipment and machinery industries.

The decline in Ontario's manufacturing output feeds through to a cumulative 2.7 percent decline in employment (relative to a 0.8 percent cumulative decline nationally). Consequently, the province experiences higher unemployment rates and lower disposable income growth. This results in an average annual reduction of 7.5 thousand people in net migration into Ontario and a cumulative 7.2 percent (or 70-thousand unit) reduction in housing starts (compared with a 2.7 percent reduction in total starts nationally.

Given the targetted nature of this tax (that being car ownership), all other regions are significantly less affected than Ontario, with aggregate output generally declining by less than the national average of 1.9 percent. However, the larger and more diversified structure of the Ontario economy ensures that the impact of this scenario on the area is less severe than the impact of the carbon tax on the Albertan economy.

TABLE 2
Cumulative Declines in Industrial Output and Employment for Gas Guzzler Tax Case

% Decline (90-2005)	National	Alberta	Ontario
GNP at Factor Cost	1.9	1.9	2.3
Total Goods Output	2.1	1.7	2.5
Mining Output	1.5	1.7	1.4
Petroleum and Coal Output*	2.2	2.2	2.2
Chemicals Output	2.6	2.4	2.7
Transportation Equipment Output	2.4	1.9	2.6
Pulp and Paper Output	1.8	1 5	1.8
Housing Starts	2.7	7.9	7.2
Employment	0.3	0.3	0.4
Unemployment Rate**	0.3	-0.1	0.1
Real Disposable Income	1.5	2.0	1.7

Cumulative Declines in Industrial Output and Employment for Moderate Gas Guzzler Tax Case

% Decline (90-2005)	National	Alberta	Ontario
GNP at Factor Cost	1.2	1.3	1.4
Total Goods Output	1.3	1.1	1.5
Mining Output	1.0	1.1	1.0
Petroleum and Coal Output	1.5	1.5	1.5
Chemicals Output	1.6	1.5	1.6
Transportation Equipment Output	1.2	0.9	1.3
Pulp and Paper Output	1.3	1.1	1.3
Housing Starts	1.5	4.9	4.1
Employment	0.2	0.1	0.2
Unemployment Rate**	0.2	-0.1	-0.0
Real Disposable Income	0.7	1.1	0.8

*Percent declines reflect relatively constant share of regional output in base case.
**Expressed as the average annual increase.

TABLE 3
Annual Transportation Costs Are Increased by the Gas Guzzler Tax by Several Times the Cost of Motor Fuel
(1990 dollars)

Extreme Case	$20,000 per vehicle and $2,000 per year registration fee
Moderate Case	$5,000 per vehicle and $500 per year registration fee

Annual Gasoline Cost ($1990)

20,000 kilometres at 10 litres per 100 kilometres equals 2000 litres

Motor Gasoline Price is $0.81 per litre in 2005

Total cost is $1620 per year

The ten-year fuel and gas guzzler cost of purchasing a large car would be $20,000 for the gas-guzzler tax, an additional $2,000 per year for 10 years for registration fees (a total of $20,000), and $1620 per year for ten years for motor fuel (a total of 16,200) – all for a grand total of $56,200. The gas-guzzler tax accounts for more than twice as much as do motor fuel costs.

Energy Results

The gas guzzler tax has its principal effect on the transportation sector and manufacturing in Ontario. The gas guzzler tax effects motor gasoline demand, the overall economy and little else. Road diesel demand is relatively unaffected and total petroleum demand is modestly reduced. There is little inflation and almost no change in relative prices.

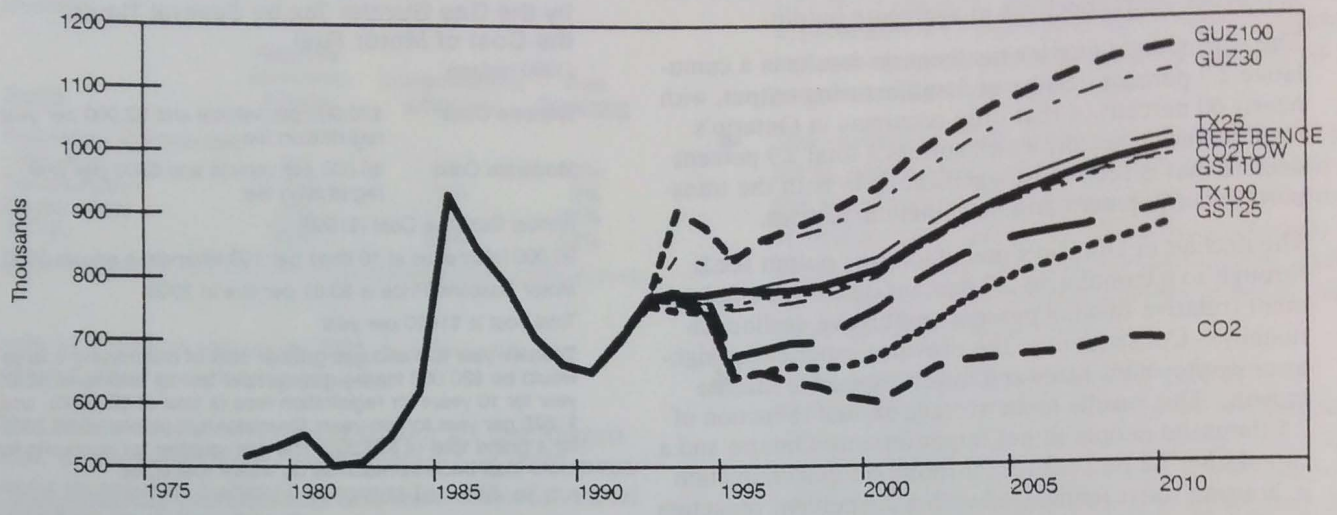
The major effect of the extreme gas guzzler tax is to flatten travel for the next decade. There are many more small cars but a dearth of large cars as this scenario progresses. Large cars are subject to up to a $20,000 initial registration fee and an annual renewal fee of

TABLE 4
Energy Demand By Sector
(Petajoules)

Sector	Reference Case	Extreme Gas Guzzler Tax	Difference	Percent
Residential	1408	1345	63	4.4%
Commercial	1049	1024	25	2.3%
Industrial	4412	4231	181	4.1%
Transportation	2545	2398	147	5.8%
Own Use	1109	1091	18	1.6%
Total	10523	10089	434	4.1%

CHART 1

Compact Car Sales Are Highest for Guzzler Tax



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GUZ100 = Gas Guzzler Extreme
CO2LOW = Carbon Tax Moderate
CO2 = Carbon Tax Extreme
GST10 = GST Moderate
GST25 = GST Extreme

$2,000. The lifetime (ten years) cost of owning a large car is increased by up to $40,000 in 1990 dollars. This leads to an early retirement of existing large cars.

Real electricity prices increase by about 10 percent in the extreme case as a consequence of the same economic effects as in the GST case. Demand is slightly lower because of reduced economic activity, while the cost of constructing numerous additional nuclear stations is also passed through to consumers.

There is a small shift in intermodal transportation. While jet fuel and diesel fuel are relatively unaffected by the gas guzzler tax, motor gasoline demand is decreased. Total passenger kilometres traveled are reduced by about 10% from the Reference Case, while motor

CHART 2

Intermediate Car Sales Lowest for Guzzler

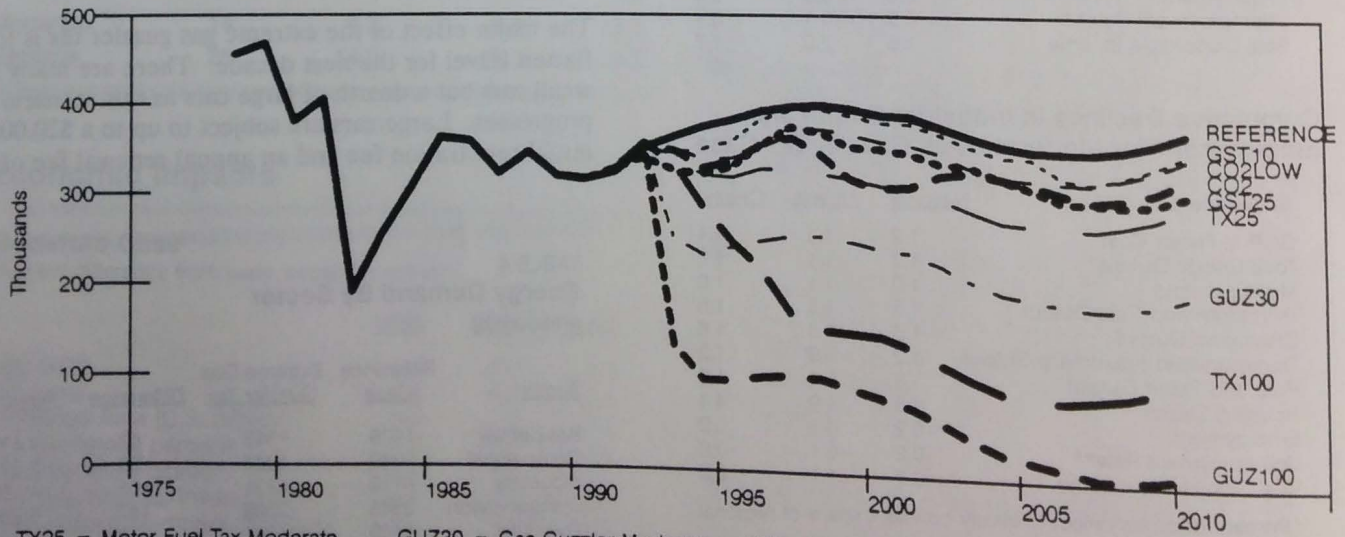

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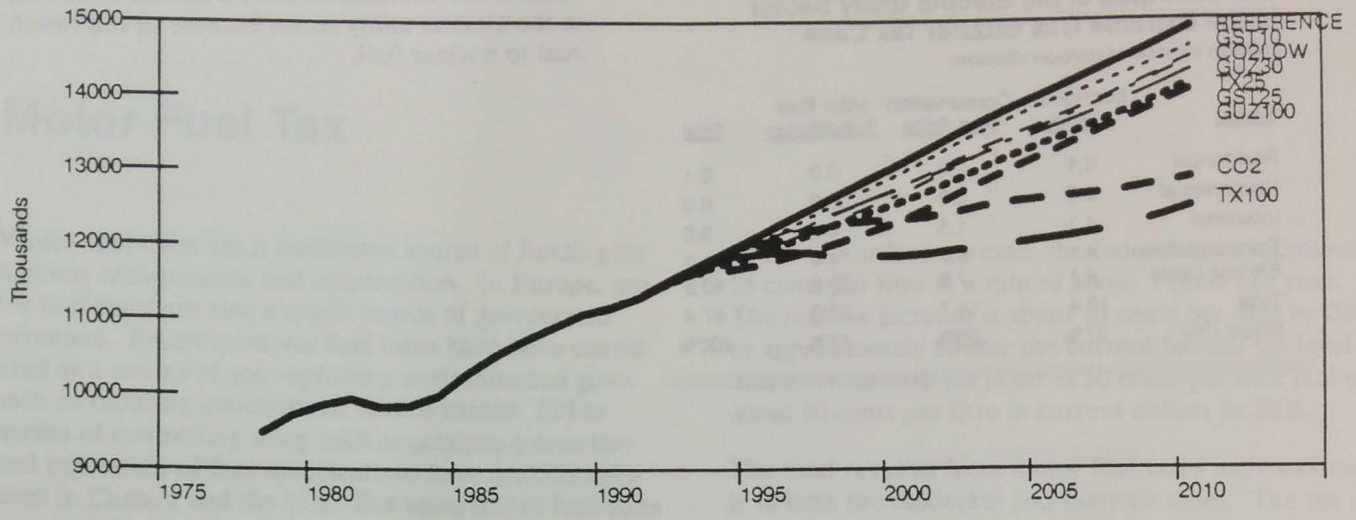
CHART 3
Passenger Car Registrations



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GST25 = GST Extreme

vehicle registrations are down by nearly one million vehicles. Consumer-based transportation—road and air—are not significantly affected by the small change in real disposable income.

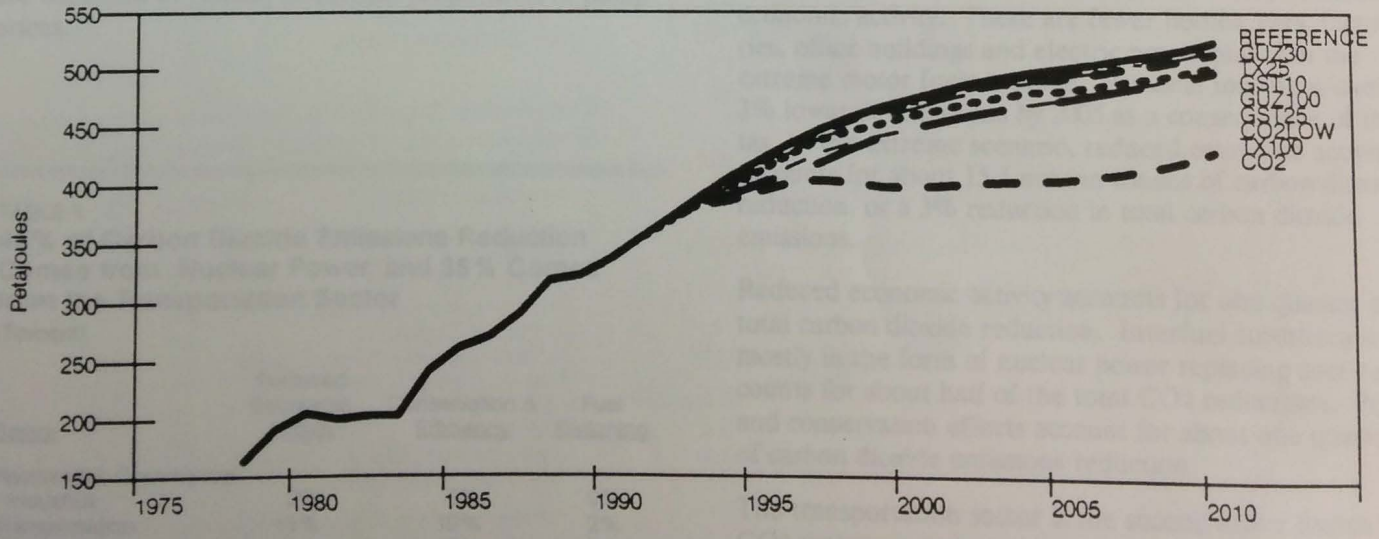
Energy Demand Results

The gas-guzzler tax and associated reduction in economic activity causes energy demand to decrease by about 4% by 2005. Most of the demand reduction is in the industrial and transportation sectors.

Carbon Dioxide Results

Carbon dioxide emissions are reduced by less than 10% in the extreme gas-guzzler case. Reductions by sector are varied; there is little impact on the residential, commercial and industrial sectors. The transportation sector

CHART 4
Road Diesel Demand Is Lowest for Carbon Tax and Small Impact from Gas Guzzler Tax



TX25 = Motor Fuel Tax Moderate
TX100 = Motor Fuel Tax Extreme
GUZ30 = Gas Guzzler Moderate
GUZ100 = Gas Guzzler Extreme
CO2LOW = Carbon Tax Moderate
CO2 = Carbon Tax Extreme
GST10 = GST Moderate
GST25 = GST Extreme

TABLE 5
Carbon Dioxide Emissions Reductions Are Concentrated in the Electric Utility Sector in the Extreme Gas Guzzler Tax Case
(Million tonnes of carbon dioxide)

Sector	Economic Activity	Conservation And Price	Inter Fuel Substitution	Total
Residential	0.1	0.0	0.0	0.1
Commercial	0.0	0.0	0.0	0.0
Industrial	4.1	1.5	0.0	5.6
Transportation	4.1	5.7	1.4	11.2
Electric Utility	4.1	7.5	28.9	40.5
Total	12.4	14.7	30.3	57.4
Share (%)	22%	26%	52%	100%

shows lower CO_2 emissions approximately in line with the reductions in energy demand.

Most of the decrease in carbon dioxide emissions occurs in the electric utility sector because of the switch from coal to nuclear fuel.

Motor Fuel Tax

Motor fuel taxes are a traditional source of funding for highway maintenance and construction. In Europe, motor fuel taxes are also a major source of government revenues. Recently, motor fuel taxes have been considered as a means of accomplishing environmental goals such as reducing emissions of nitrous oxides. Other means of controlling smog such as catalytic converters and regulation of fuel specifications have actually been used in Canada and the U.S. But using motor fuel taxes reduce CO_2 emissions is untried.

Since the transportation sector accounts for a modest portion of CO_2 emissions, any policy solely directed at transportation will by necessity fail to prevent growth in overall CO_2 emissions. From 1990 to 2005, trend growth in CO_2 emissions is larger than the total CO_2 emissions from the transportation sector. At best, a motor fuel tax can make only a small contribution to CO_2 emissions reductions.

Motor fuel taxes are imposed on retail sales on a cents per litre basis. The federal government has increased motor fuel taxes by 1 to 2 cents per year since 1985. The Reference Case has a constant real motor fuels tax. Provinces have taxes of about 20 percent of pump prices or about 10 cents per litre. Provincial motor fuel taxes are expected to remain at current proportions of pump prices.

TABLE 1
45% of Carbon Dioxide Emissions Reduction Comes from Nuclear Power, and 36% Comes from the Transportation Sector
(Percent)

Sector	Reduced Economic Activity	Conservation & Efficiency	Fuel Switching
Residential, Commercial, Industrial	2%	2%	0%
Transportation	15%	19%	2%
Electric Utility	7%	8%	45%
TOTAL	24%	29%	47%

In the motor fuel tax case, the federal tax is increased by 25 cents per litre at a rate of about 5 cents per year. The real tax increase is about 10 cents per litre by 2005 or approximately double the current federal tax level. The extreme-case tax is set at 50 cents per litre real or about 90 cents per litre in current dollars in 2005.

The total revenue from motor fuel taxes increases rapidly in both the moderate and extreme cases. The tax is set equal for motor gasoline and diesel fuel but is not extended to other transportation fuels such as natural gas and propane.

Motor fuel taxes are linked to three aspects of motor fuel demand in the Canadian Energy Model. First, taxes have an impact upon vehicle sales. The 1981 decision by Quebec to impose a 40 percent Provincial Motor Fuels Tax had an extremely negative effect on car sales. Second, the price of gasoline is combined with new car efficiency as an explanatory variable for car sales by size. The greater the tax, the more incentive to purchase small vehicles. Third, the price of gasoline affects the level of utilization. Vehicle kilometres traveled are reduced by an increase in motor fuel taxes.

Carbon dioxide emissions are also affected by reduced economic activity. There are fewer homes, cars, factories, office buildings and electric power plants in the extreme motor fuels tax case. Personal income is over 3% lower in real terms by 2005 as a consequence of the tax. In the extreme scenario, reduced economic activity accounts for about 15.5 million tonnes of carbon dioxide reduction, or a 3% reduction in total carbon dioxide emissions.

Reduced economic activity accounts for one quarter of total carbon dioxide reduction. Interfuel substitution—mostly in the form of nuclear power replacing coal—accounts for about half of the total CO_2 reductions. Price and conservation effects account for about one quarter of carbon dioxide emissions reduction.

The transportation sector is the second major source of CO_2 emissions reductions in the motor tax case. The motor fuel tax significantly lowers vehicle sales and travel, which in turn reduces fuel use.

Policy Assumptions

The increase in motor gasoline taxes raised the price of gasoline (which has a weight of 4.6 percent in the CPI) and led to the following decline in car sales:

	Percent Change In CPI - Gasoline		Car Sales	
	1995	2005	1995	2005
Moderate	15.9	15.9	-4.8	-4.3
Extreme	43.5	68.2	-11.5	-17.6

Economic Impacts

Moderate Case

(Percent difference from base, except as noted)

	1995	2000	2005
Real GDP	-0.6	-0.2	-0.1
CPI Level	0.6	0.4	0.5
Exchange Rate (U.S. cents)	0.6	0.5	0.5
Interest Rates (percent)	0.1	0.0	0.0
Trade Balance ($billion)	1.4	2.3	2.1
Business Nonres. Investment	-1.2	0.5	1.2
Direct Revenue Impact ($billion)	4.5	7.2	9.8

- In the moderate case the CPI is raised by a maximum 0.8 percent in 1994, and remains 0.5 percent higher in 2005.
- The economy drops by a maximum 0.6 percent in 1994, and is below base values throughout the period. As in the gas guzzler case, the consumer is particularly hard hit, business reduces its motor vehicle purchases, and exports suffer.
- Even though imports of transportation equipment fall by proportionately less than do motor vehicle purchases (to reflect the switch to more fuel efficient cars that are produced outside Canada), weaker domestic demand does lead to a small improvement in our merchandise trade balance.

Extreme Case

(Percent difference from base, except as noted)

	1995	2000	2005
Real GDP	-1.5	0.3	-0.6
CPI Level	2.1	1.9	3.6
Exchange Rate (U.S. cents)	2.1	1.9	1.6
Interest Rates (percent)	0.8	0.0	0.0
Trade Balance ($billion)	2.9	4.7	6.2
Business Nonres. Investment	-2.1	+2.9	+2.6
Direct Revenue Impact ($billion)	12.1	26.7	35.3

- In the extreme case, the CPI is boosted by 2.1 percent by 1995, which increases to 3.7 percent at the projection horizon.
- The economy is negatively effected throughout almost the entire period, with the largest drop of 1.7 percent occurring in 1997. The larger price impact in the extreme scenario elicits an investment response by the turn of the century, which briefly returns the economy to base-case levels.
- As in the moderate case, the consumer is hardest hit, and exports suffer. Energy investment is higher after 2000; nevertheless, the trade balance registers a modest improvement.

Regional and Industrial Impacts

The higher price of gasoline in these scenarios and the associated lower consumption of motor fuel results in lower output of refined petroleum products and hence lower demand for crude oil. In addition, the higher price of gasoline lowers car sales and reduces the output of transportation equipment.

TABLE 2

Cumulative Declines in Industrial Output and Employment for Severe Motor Fuel Tax Case

% Decline (90-2005)	National	Alberta	Ontario
GNP at Factor Cost	2.4	3.6	2.3
Total Goods Output	2.4	3.8	1.9
Mining Output	3.5	4.7	2.1
Petroleum and Coal Output*	6.8	6.8	6.8
Chemicals Output	2.1	1.8	2.1
Transportation Equipment Output	1.2	0.7	1.3
Pulp and Paper Output	2.0	1.7	2.0
Housing Starts	7.2	19.9	9.3
Employment	0.3	3.2	-0.2
Unemployment Rate**	0.3	1.4	-0.4
Real Disposable Income	3.1	6.7	2.4

Cumulative Declines in Industrial Output and Employment for Moderate Motor Fuel Tax Case

% Decline (90-2005)	National	Alberta	Ontario
GNP at Factor Cost	1.0	1.4	1.0
Total Goods Output	0.9	1.3	0.7
Mining Output	1.2	1.6	0.8
Petroleum and Coal Output	2.3	2.3	2.3
Chemicals Output	1.0	0.9	1.1
Transportation Equipment Output	0.6	0.5	0.7
Pulp and Paper Output	0.8	0.7	0.8
Housing Starts	2.0	9.7	2.5
Employment	0.1	1.0	0.0
Unemployment Rate**	0.1	0.4	-0.1
Real Disposable Income	1.1	2.1	0.9

*Percent declines reflect relatively constant share of regional output in base case.

**Expressed as the average annual increase.

Nationally, aggregate output falls 2.4 percent in the extreme scenario, with the lion's share of that decline occurring in Alberta, which suffers a 3.6 percent cumulative decrease. This reflects a total 4.7 percent drop in mining output in Alberta relative to a 3.5 percent decline in national mining output. Reflecting the relatively large negative impact of this tax on Alberta, net migration into the province declines, resulting in a cumulative 2.1 percent decline in population there, when compared with the base case.

Ontario output declines relative to the base case by a cumulative 2.3 percent (approximately equal to the national decline). This is the result of only a 1.5 percent decrease in manufacturing output at the national level, with only a 1.2 percent decline in transportation equipment, although 83 percent of that drop occurs in Ontario. Of all the manufacturing industries, refined petroleum and coal products are hurt the most, suffering declines of 6.8 percent nationally, with the losses evenly distributed across all regions.

Energy Results

The motor fuels tax has its principal impact on the transportation sector, including motor gasoline and road diesel consumption. In fact, the principal difference between the motor gasoline tax scenario and the gas guzzler tax is that road diesel is hit hard along with motor gasoline. Travel per capita is lower in this case than in the 1982 recession as a consequence of the gasoline tax hike. In fact, in most years, travel per capita is declining. Both motor gasoline and road diesel prices increase by 60 percent in real terms compared to the Reference Case.

TABLE 3
Motor Fuel Price Increases Are Dominated by Federal Taxes
(Dollars per litre in 2005)

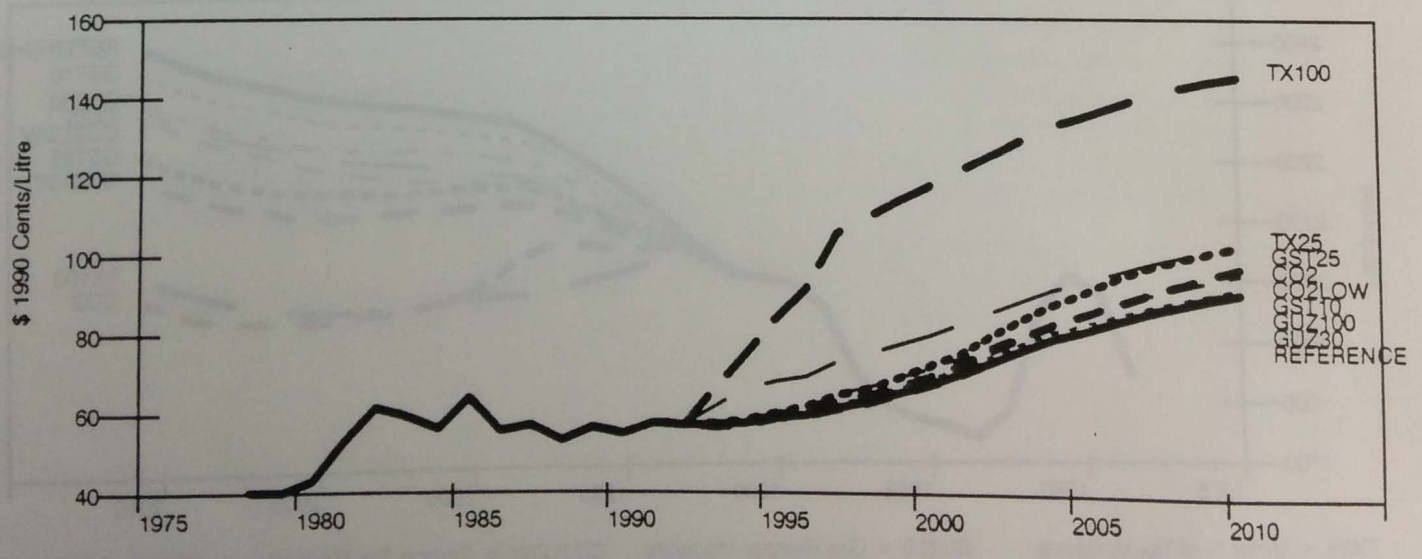
	Reference Case	Motor Fuel Tax Case
Wholesale Price	.78	.78
Federal Tax	.39	1.29
Ontario Tax	.25	.43
Distribution	.14	.14
Pump Price	1.56	2.64

The motor fuel tax cases do not share the extensive manufacturing reduction of the gas guzzler tax. Small car sales are assisted by the motor fuel tax though not in quite the proportion as in the gas guzzler scenario. Also, the impacts are spread across all vehicle types.

The tax revenue raised is substantial, reaching over 85 billion dollars per year (nominal) by 2010. One consequence of the tax is that vehicle registrations are lower in this case then in the gas guzzler tax case.

Motor gasoline prices are increased by about two thirds by the extreme motor fuels tax. By 2005, the extreme tax reaches $1.29 per litre or $0.90 more than in the Reference case. Provincial taxes are increased in order to

CHART 1
Taxes Raise Motor Fuel Prices



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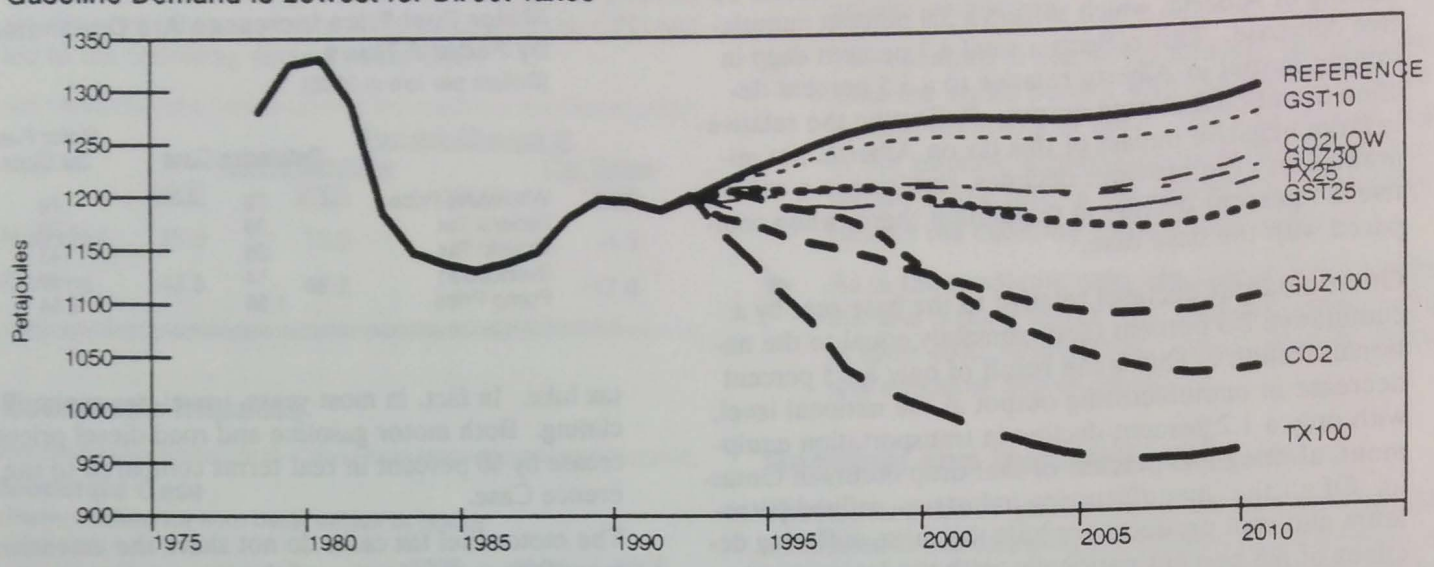
GST10 = GST Moderate
GST25 = GST Extreme

CHART 2

Gasoline Demand Is Lowest for Direct Taxes



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stabilize the total motor fuel tax revenue of the provinces.

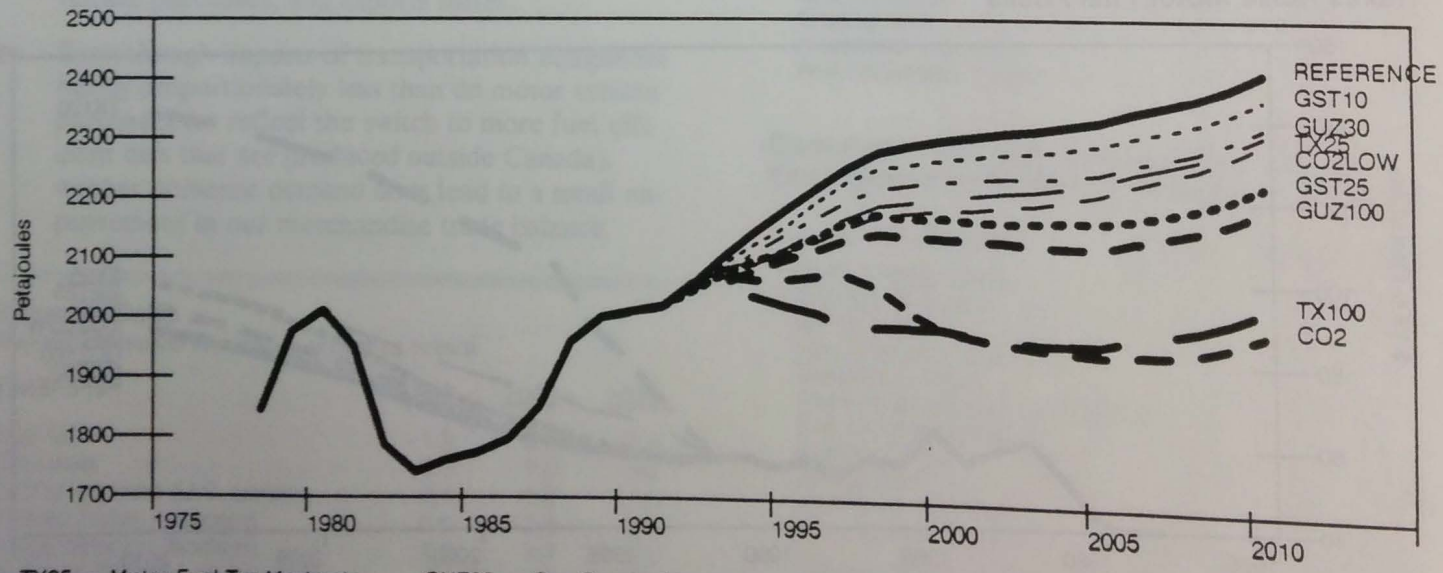
Energy Demand

The motor fuels tax and associated reduction in economic activity causes energy demand to decrease by about 3% by 2005. The transportation sector accounts for most of the reduction in energy demand; other consuming sectors experience only only minor changes.

Intermodal shifts in transportation are significant, since all types of road-fuel use decrease in the extreme motor tax scenario. Rail, air and marine transportation show minor effects from the economic effects of a motor fuels tax.

CHART 3

Transportation Demand Lowest for Direct Taxes



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GST10 = GST Moderate
GST25 = GST Extreme

TABLE 3
Energy Demand By Sector
(Petajoules)

Sector	Reference Case	Extreme Motor Fuel Tax	Difference	Percent
Residential	1408	1352	56	3.9%
Commercial	1049	1029	20	1.9%
Industrial	4412	4381	31	0.7%
Transportation	2545	2304	241	9.5%
Own Use	1109	1100	9	0.1%
Total	10523	10166	357	3.4%

Motor vehicle registrations are about 700 thousand less by 2005 than in the Reference case. Total vehicle kilometres traveled is reduced by nearly 20% to 261 billion, compared with nearly 320 billion in the Reference case.

Carbon Dioxide Results

Carbon dioxide emissions are reduced by about 10% in the extreme motor-fuels tax case. Reductions are concentrated in the transportation and electric utility sectors. The other consuming sectors show very minor reductions in CO_2 emissions, paralleling the minimal change in energy demand.

The electric utility sector experiences almost no reduction in fuel use, yet shows a major decrease in carbon dioxide emissions. The switch from coal to nuclear fuel accounts for three quarters of the decrease in carbon dioxide in the utility sector.

TABLE 4
Carbon Dioxide Emissions Reductions Are Concentrated In the Transportation and Electric Utility Sector In the Extreme Motor Fuels Tax Case
(Million tonnes of carbon dioxide)

Sector	Economic Activity	Conservation And Price	Inter Fuel Substitution	Total
Residential	0.2	0.0	0.0	0.2
Commercial	0.2	0.0	0.0	0.2
Industrial	1.2	1.5	0.0	2.7
Transportation	9.3	11.9	1.4	22.6
Electric Utility	4.6	4.9	28.9	38.4
Total	15.5	18.3	30.3	64.1
Share (%)	24%	29%	47%	100%

Conclusions

When carbon dioxide emissions were reduced in the past—specifically, 1980 to 1983—the experience of the price shock and recession was one of pain for energy consumers and energy producers. Economic shock was accompanied by government intervention in market decisions. Such events ultimately disrupt normal economic, commercial and political decision-making. In particular, political decisions carry an inherent responsibility to all parts of society such that a single-minded goal is usually unworkable. Tradeoffs must be made between CO_2 reduction, economic growth and other environmental issues.

Taxes hefty enough to reduce CO_2 emissions have significant macroeconomic effects. Taxes on energy raise prices to consumers, ultimately causing inflation. Producers do not share in the price increases, altering the allocation of resources within the economy. And higher energy prices mean a loss of industrial competitiveness and a consequent deterioration of the trade accounts. Narrowly based policies have more severe consequences for foreign trade than do broad-based policies.

The taxes also differentiate by region, with energy-producing provinces such as Alberta facing the most severe adjustment costs for such levies as the carbon tax. Ontario has the most extensive impact from the gas guzzler tax. Quebec fares relatively better than other regions across all tax cases. Much of Quebec's energy comes from hydro power, which is relatively unaffected by the four tax scenarios considered in this study.

What all the scenarios show is that direct taxes are a poor way of reducing CO_2 emissions. The major impact on CO_2 comes from new nuclear plants replacing coal-fired generation. Secondary improvements in CO_2 emissions occur from automotive efficiency gains, conservation, and increased use of natural gas.

Taxes on CO_2 are taxes on energy consumption. Coal emits the greatest amount of CO_2 per unit of energy, while natural gas emits half that of coal, and nuclear and hydro power emit no CO_2. The simplest way to reduce CO_2 emissions from energy is to substitute natural gas, nuclear and hdyropower for coal.

Carbon Taxes Lower Economy More

- In both the moderate and extreme cases, the largest drop in real economic activity results from the imposition of carbon taxes. In the moderate case, cumulative real GDP declines by $40 billion, or about 0.4 percent, over the period 1990-2005. Cumulative real GDP declines by over $100 billion, or 1.1 percent, in the extreme case.
- In terms of the inflation cost, the carbon tax scenarios represent some of the most severe impacts. In the moderate case, the CPI level is increased by a cumulative 1.9 percent (the largest increase), while in the extreme case, the CPI level is increased by over 10 percent, cumulatively (the second largest increase after the goods and services tax, or GST).

The carbon tax is set in proportion to carbon content. Thus the carbon tax causes a high propensity to switch fuels. Generally, the taxes are very effective in reducing consumption of those items taxed, be they large cars, motor fuels, carbon content or economic activity. The carbon tax causes the largest decrease in GDP and has the most severe effects on the Alberta mining industry.

The gas guzzler tax is a particularly inefficient way of reducing CO_2 emissions since its primary effect is to reduce manufacturing activity and imbalance existing international trade patterns. Also, narrowly based policies such as the gas guzzler tax exact the largest costs in terms of foreign economic activity. The gas guzzler tax also has very pronounced effects on the Ontario economy.

The GST is a broad-based tax that does not differentiate by carbon content. The effect on electricity is enormous. Lower economic activity and higher inflation add to electricity price increases such that electricity demand

TABLE 1
The Gas Guzzler Tax Has by Far the Worst Economic to CO_2 Reduction Tradeoff of All the Scenarios.

	CO_2	GDP Loss	Ratio ($/Tonne)	Inflation	Mining	Manufacturing
			Ranking from Best to Worse			
Moderate Cases						
1	CO_2	GST	CO_2	GUZZLER	GUZZLER	MOGASTAX
2	GST	MOGASTAX	MOGASTAX	MOGASTAX	MOGASTAX	GUZZLER
3	GUZZLER	GUZZLER	GST	CO_2	GST	CO_2
4	MOGASTAX	CO_2	GUZZLER	GST	CO_2	GST
Extreme Cases						
1	CO_2	GST	GST	GUZZLER	GUZZLER	MOGASTAX
2	GST	MOGASTAX	MOGASTAX	MOGASTAX	MOGASTAX	GUZZLER
3	GUZZLER	GUZZLER	CO_2	GST	CO_2	GST
4	MOGASTAX	CO_2	GUZZLER	CO_2	GST	CO_2

is nearly flat in this case, compared with moderate growth in all other scenarios.

The motor fuels tax is borne by consumers and results in a significant increase in inflation. Since both gasoline and diesel consumption is targeted by this tax, and since the tax does not differentiate by class or type of vehicle, the effects on energy consumption and CO_2 emissions are achieved with a lesser impact on economic activity than in the gas guzzler scenarios.

Similarly, all of the cases can be compared in terms of their economic efficiency in reducing CO_2 in dollars per tonne. The cumulative loss in real GDP between 1990 and 2005 is a measure of the social investment made in

CHART 1
Cumulative Loss in Real GDP (1990-2005) – Moderate Case
(Millions of 1981$)

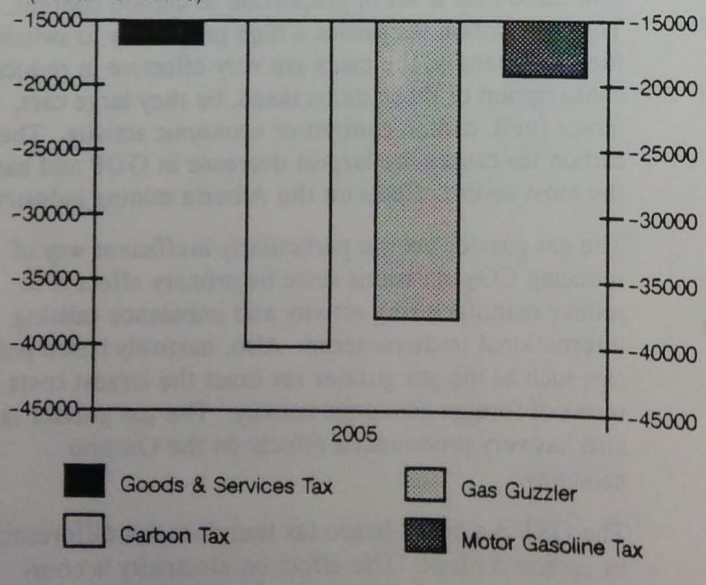


CHART 2
Cumulative Loss in Real GDP (1990-2005) – Extreme Case
(Millions of 1981$)

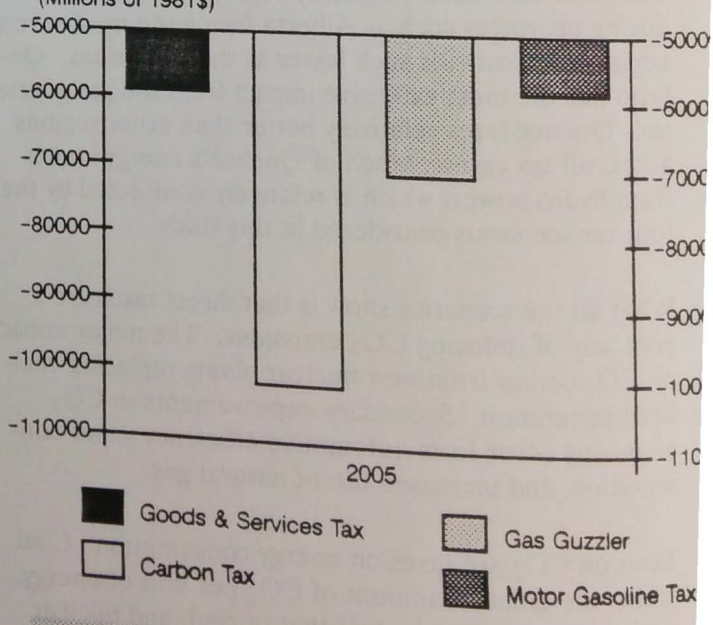


CHART 3

Cumulative Increase in the CPI – Moderate Case

(Percent difference from base in 2005)

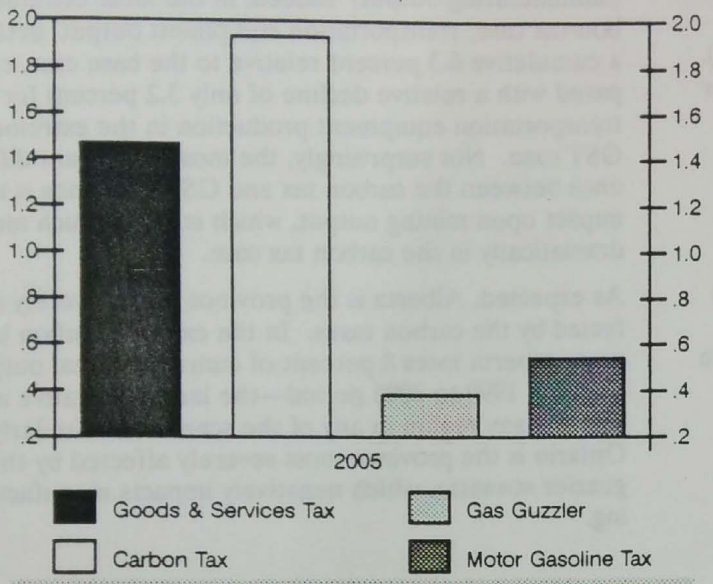
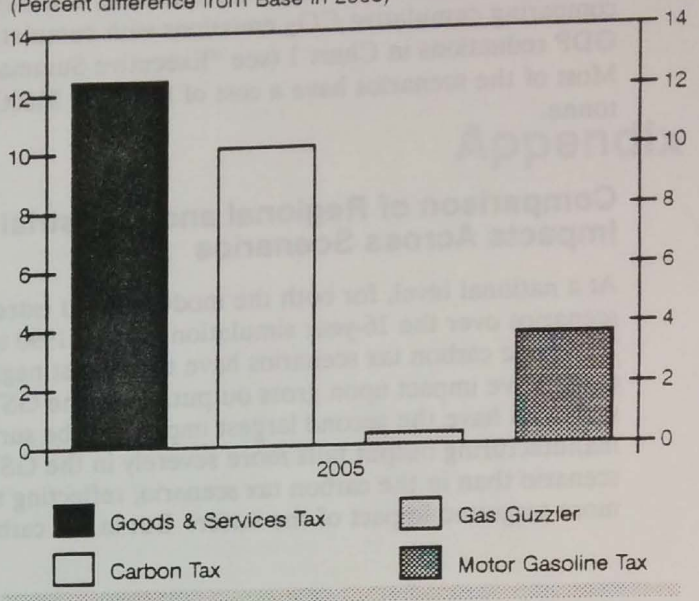


CHART 4

Cumulative Increase in the CPI – Extreme Case

(Percent difference from Base in 2005)



CO_2 reduction. The cumulative reduction in CO_2 emissions is the result.

Carbon dioxide has a high cost per person. In 1990, CO_2 emissions averaged 20 tonnes per person. A typical car emits 5 tonnes of CO_2 per year, and a typical home emits 9 tonnes of CO_2 yearly. To reduce CO_2 emissions by 20 percent, each person would have to decrease emissions from a car and/or home by 4 tonnes. At a cost

CHART 5

Cumulative Percentage Loss in Mining Output in Alberta for Extreme Scenarios

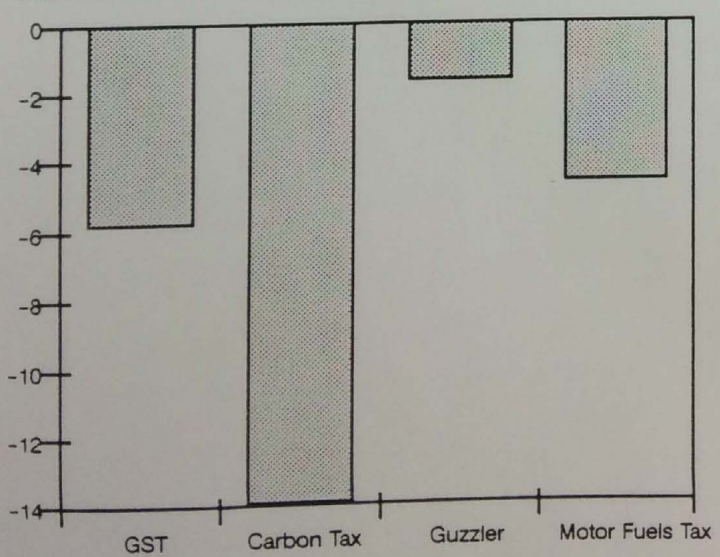
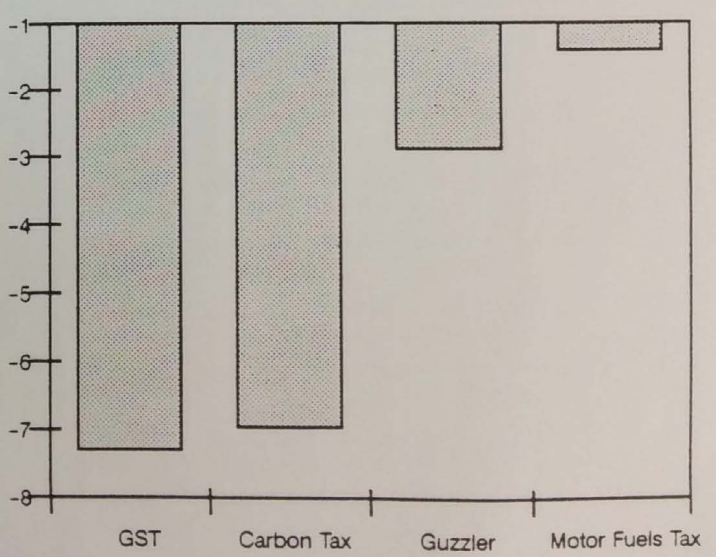


CHART 6

Cumulative Percentage Loss in Manufacturing Output in Ontario for Extreme Scenarios



of $1000 per tonne (based on the GDP loss to CO_2 ratios in this study) the per capita cost is about $4000.

In principal, the best policy to reduce CO_2 would be the one most cost effective. Cost effectiveness is shown by comparing cumulative CO_2 emissions with cumulative GDP reductions in Chart 1 (see "Executive Summary"). Most of the scenarios have a cost of less than $1000 per tonne.

Comparison of Regional and Industrial Impacts Across Scenarios

At a national level, for both the moderate and extreme scenarios over the 16-year simulation period (1990 to 2005), the carbon tax scenarios have the largest negative cumulative impact upon gross output, while the GST scenarios have the second largest impact. To be sure, manufacturing output falls more severely in the GST scenario than in the carbon tax scenario, reflecting the more targetted impact of the latter. But in the carbon tax scenario, the higher cost of gasoline and subsequent lower demand for automobiles results in a more significant negative impact on the output of transportation equipment, despite the relatively smaller decline in manufacturing output. Indeed, in the most extreme carbon-tax case, transportation equipment output declines a cumulative 6.3 percent relative to the base case, compared with a relative decline of only 3.2 percent for transportation equipment production in the extreme GST case. Not surprisingly, the most significant difference between the carbon tax and GST scenarios is the impact upon mining output, which is down much more dramatically in the carbon tax case.

As expected, Alberta is the province most severely affected by the carbon taxes. In the extreme carbon tax case, Alberta loses 8 percent of cumulative real output over the 1990 to 2005 period—the largest negative impact for any region in any of the scenarios. Similarly, Ontario is the province most severely affected by the gas guzzler scenario, which negatively impacts manufacturing.

Appendix

TABLE 1

Regional Impacts of Alternative Government Policies Ranked by Relative Severity of National Impact

Alternative Policies	Canada	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Atlantic
	Cumulative Difference from Base Case For 1990 to 2005							
Aggregate Output ($81 Million)								
1) Carbon Tax – Extreme Case.....	-566,314	-65,617	-94,663	-19,347	-22,233	-227,931	-97,462	-39,062
% Diff.....	-6.6	-6.7	-8.1	-6.3	-7.1	-6.8	-5.2	-7.4
2) GST – Extreme Case.....	-380,495	-45,158	-55,618	-12,799	-13,982	-155,915	-66,526	-30,497
% Diff.....	-4.5	-4.6	-4.8	-4.2	-4.4	-4.7	-3.5	-5.7
3) Motor Fuel Tax – Extreme Case..	-208,383	-25,473	-42,390	-7,991	-8,822	-76,381	-33,013	-14,312
% Diff.....	-2.4	-2.6	-3.6	-2.6	-2.8	-2.3	-1.7	-2.7
4) Gas Guzzler Tax – Extreme Case.	-163,393	-17,920	-21,648	-4,594	-5,776	-75,727	-30,189	-7,540
% Diff.....	-1.9	-1.8	-1.9	-1.5	-1.8	-2.3	-1.6	-1.4
5) Carbon Tax – Moderate Case.....	-153,899	-19,127	-33,142	-4,809	-5,065	-64,683	-21,065	-6,008
% Diff.....	-1.8	-1.9	-2.8	-1.6	-1.6	-1.9	-1.1	-1.1
6) GST – Moderate Case.....	-144,788	-15,049	-18,405	-4,505	-5,673	-61,222	-28,825	-11,110
% Diff.....	-1.7	-1.5	-1.6	-1.5	-1.8	-1.8	-1.5	-2.1
7) Gas Guzzler Tax – Moderate Case	-105,419	-12,066	-14,583	-3,118	-3,860	-47,712	-19,663	-4,419
% Diff.....	-1.2	-1.2	-1.3	-1.0	-1.2	-1.4	-1.0	-0.8
8) Motor Fuel Tax – Moderate Case.	-85,557	-10,252	-15,818	-3,186	-3,405	-32,428	-15,133	-5,334
% Diff.....	-1.0	-1.0	-1.4	-1.0	-1.1	-1.0	-0.8	-1.0

TABLE 2

Regional Impacts of Alternative Government Policies Ranked by Relative Severity of National Impact

Alternative Policies	Canada	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Atlantic
	Cumulative Difference from Base Case For 1990 to 2005							
Manufacturing Output ($81 Million)								
1) GST – Extreme Case.....	-121,142	-11,505	-5,380	-1,154	-3,020	-66,492	-30,207	-3,384
% Diff.....	-7.2	-6.8	-5.7	-7.6	-7.2	-7.3	-7.5	-7.0
2) Carbon Tax – Extreme Case.....	-114,540	-10,761	-5,515	-1,051	-2,894	-63,453	-27,524	-3,342
% Diff.....	-6.8	-6.4	-5.8	-6.9	-6.9	-7.0	-6.8	-6.9
3) Gas Guzzler Tax – Extreme Case.	-44,616	-3,402	-1,948	-380	-1,142	-26,316	-10,348	-1,081
% Diff.....	-2.7	-2.0	-2.1	-2.5	-2.7	-2.9	-2.6	-2.2
4) GST – Moderate Case.....	-42,327	-3,470	-1,527	-382	-1,138	-24,125	-10,561	-1,124
% Diff.....	-2.5	-2.1	-1.6	-2.5	-2.7	-2.6	-2.6	-2.3
5) Carbon Tax – Moderate Case.....	-30,829	-2,694	-1,269	-303	-791	-17,488	-7,337	-948
% Diff.....	-1.8	-1.6	-1.3	-2.0	-1.9	-1.9	-1.8	-2.0
6) Gas Guzzler Tax – Moderate Case	-26,434	-2,165	-1,220	-233	-665	-15,268	-6,199	-684
% Diff.....	-1.6	-1.3	-1.3	-1.5	-1.6	-1.7	-1.5	-1.4
7) Motor Fuel Tax – Extreme Case..	-24,758	-2,617	-1,466	-259	-541	-12,857	-6,093	-925
% Diff.....	-1.5	-1.5	-1.6	-1.7	-1.3	-1.4	-1.5	-1.9
8) Motor Fuel Tax – Moderate Case.	-9,886	-1,058	-610	-99	-212	-5,076	-2,449	-382
% Diff.....	-0.6	-0.6	-0.6	-0.7	-0.5	-0.6	-0.6	-0.8

TABLE 3

Regional Impacts of Alternative Government Policies Ranked by Relative Severity of National Impact

Alternative Policies	Canada	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Atlantic
	Cumulative Difference from Base Case For 1990 to 2005							
Mining Output ($81 Million)								
1) Carbon Tax – Extreme Case.....	-52,570	-3,646	-37,018	-3,169	-1,348	-4,549	-1,387	-1,454
% Diff.....	-10.6	-7.3	-13.9	-8.6	-7.2	-6.5	-5.3	-5.1
2) GST – Extreme Case.....	-27,790	-2,591	-15,427	-2,068	-1,026	-3,835	-1,471	-1,373
% Diff.....	-5.6	-5.2	-5.8	-5.6	-5.5	-5.5	-5.6	-4.8
3) Motor Fuel Tax – Extreme Case..	-17,400	-1,120	-12,494	-1,173	-420	-1,451	-405	-337
% Diff.....	-3.5	-2.2	-4.7	-3.2	-2.2	-2.1	-1.5	-1.2
4) Carbon Tax – Moderate Case.....	-17,343	-963	-13,339	-1,068	-356	-1,124	-253	-240
% Diff.....	-3.5	-1.9	-5.0	-2.9	-1.9	-1.6	-1.0	-0.8
5) GST – Moderate Case.....	-7,992	-681	-4,621	-619	-281	-1,063	-392	-337
% Diff.....	-1.6	-1.4	-1.7	-1.7	-1.5	-1.5	-1.5	-1.2
6) Gas Guzzler Tax – Extreme Case.	-7,567	-627	-4,456	-580	-261	-985	-362	-296
% Diff.....	-1.5	-1.3	-1.7	-1.6	-1.4	-1.4	-1.4	-1.0
7) Motor Fuel Tax – Moderate Case.	-6,093	-415	-4,178	-430	-162	-578	-176	-154
% Diff.....	-1.2	-0.8	-1.6	-1.2	-0.9	-0.8	-0.7	-0.5
8) Gas Guzzler Tax – Moderate Case	-5,131	-436	-2,994	-390	-179	-673	-249	-209
% Diff.....	-1.0	-0.9	-1.1	-1.1	-1.0	-1.0	-1.0	-0.7

TABLE 4

Regional Impacts of Alternative Government Policies Ranked by Relative Severity of National Impact

Alternative Policies	Canada	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Atlantic
	Cumulative Difference from Base Case For 1990 to 2005							
Population (000's)								
1) GST – Moderate Case.....	0	-65	-147	128	-326	-405	796	18
% Diff.....	0.0	-0.1	-0.3	0.8	-1.8	-0.2	0.7	0.0
2) GST – Extreme Case.....	0	-527	-562	316	-853	-1,276	2,937	-35
% Diff.....	0.0	-0.9	-1.3	1.9	-4.6	-0.8	2.6	-0.1
3) Gas Guzzler Tax – Moderate Case	0	-34	-156	120	-168	-441	851	-172
% Diff.....	0.0	-0.1	-0.4	0.7	-0.9	-0.3	0.8	-0.4
4) Gas Guzzler Tax – Extreme Case.	0	-35	-235	186	-257	-737	1,303	-225
% Diff.....	0.0	-0.1	-0.5	1.1	-1.4	-0.4	1.2	-0.6
5) Motor Fuel Tax – Moderate Case.	0	-31	-308	85	-166	-210	762	-131
% Diff.....	0.0	-0.1	-0.7	0.5	-0.9	-0.1	0.7	-0.3
6) Motor Fuel Tax – Extreme Case..	0	-193	-903	176	-428	-534	2,278	-396
% Diff.....	0.0	-0.3	-2.1	1.0	-2.3	-0.3	2.0	-1.0
7) Carbon Tax – Moderate Case.....	0	-151	-1,331	110	-105	-354	2,314	-483
% Diff.....	0.0	-0.3	-3.0	0.6	-0.6	-0.2	2.0	-1.3
8) Carbon Tax – Extreme Case.....	0	-218	-2,952	475	-857	-934	5,139	-652
% Diff.....	0.0	-0.4	-6.7	2.8	-4.6	-0.6	4.5	-1.7

TABLE 5

Regional Impacts of Alternative Government Policies Ranked by Relative Severity of National Impact

Alternative Policies	Canada	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Atlantic
	Cumulative Difference from Base Case For 1990 to 2005							
Real Personal Disposable Income ($81 Million)								
1) Carbon Tax – Extreme Case.....	-189,178	-34,419	-26,157	-9,225	-15,743	-57,594	-23,889	-28,528
% Diff.....	-3.3	-4.8	-4.5	-5.0	-7.4	-2.6	-1.7	-7.1
2) Motor Fuel Tax – Extreme Case..	-177,305	-30,974	-38,637	-7,790	-10,005	-54,657	-27,768	-15,562
% Diff.....	-3.1	-4.4	-6.7	-4.2	-4.7	-2.4	-2.0	-3.9
3) GST – Extreme Case.....	-150,104	-28,932	-40,197	-10,143	-13,075	-32,352	-6,265	-30,594
% Diff.....	-2.6	-4.1	-7.0	-5.4	-6.2	-1.4	-0.5	-7.6
4) Carbon Tax – Moderate Case.....	-99,278	-18,983	-17,934	-4,070	-5,290	-39,076	-13,243	-2,306
% Diff.....	-1.8	-2.7	-3.1	-2.2	-2.5	-1.7	-1.0	-0.6
5) Gas Guzzler Tax – Extreme Case.	-86,444	-12,499	-11,348	-3,145	-4,647	-38,870	-13,840	-3,406
% Diff.....	-1.5	-1.8	-2.0	-1.7	-2.2	-1.7	-1.0	-0.9
6) GST – Moderate Case.....	-64,690	-7,582	-9,795	-2,936	-4,332	-20,924	-10,073	-11,050
% Diff.....	-1.1	-1.1	-1.7	-1.6	-2.0	-0.9	-0.7	-2.8
7) Motor Fuel Tax – Moderate Case.	-60,025	-9,970	-12,070	-2,494	-3,279	-19,929	-10,287	-4,247
% Diff.....	-1.1	-1.4	-2.1	-1.3	-1.5	-0.9	-0.8	-1.1
8) Gas Guzzler Tax – Moderate Case	-41,756	-6,797	-6,094	-1,665	-2,587	-18,557	-6,450	-347
% Diff.....	-0.7	-1.0	-1.1	-0.9	-1.2	-0.8	-0.5	-0.1

TABLE 6

Regional Impacts of Alternative Government Policies Ranked by Relative Severity of National Impact

Alternative Policies	Canada	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Atlantic
	Cumulative Difference from Base Case For 1990 to 2005							
Housing Starts								
1) GST – Extreme Case.....	-425,521	-115,343	-73,790	-1,219	-22,663	-224,958	41,399	-28,949
% Diff.....	-16.1	-23.2	-26.8	-2.2	-33.5	-23.0	7.4	-13.4
2) Carbon Tax – Extreme Case.....	-260,318	-82,406	-64,885	14,898	-17,386	-180,753	121,319	-51,104
% Diff.....	-9.8	-16.6	-23.5	26.3	-25.7	-18.4	21.8	-23.6
3) Motor Fuel Tax – Extreme Case..	-191,935	-54,885	-54,819	1,362	-14,813	-91,006	75,796	-53,568
% Diff.....	-7.2	-11.1	-19.9	2.4	-21.9	-9.3	13.6	-24.7
4) GST – Moderate Case.....	-115,817	-21,718	-18,174	2,619	-14,007	-60,264	-7,528	3,255
% Diff.....	-4.4	-4.4	-6.6	4.6	-20.7	-6.2	-1.4	1.5
5) Carbon Tax – Moderate Case.....	-80,435	-31,860	-46,249	9,850	-784	-56,277	98,105	-53,219
% Diff.....	-3.0	-6.4	-16.8	17.4	-1.2	-5.7	17.6	-24.5
6) Gas Guzzler Tax – Extreme Case.	-71,022	-8,517	-21,775	7,943	-11,574	-70,305	68,544	-35,339
% Diff.....	-2.7	-1.7	-7.9	14.0	-17.1	-7.2	12.3	-16.3
7) Motor Fuel Tax – Moderate Case.	-53,805	-10,826	-26,731	1,837	-8,522	-24,006	33,340	-18,897
% Diff.....	-2.0	-2.2	-9.7	3.2	-12.6	-2.5	6.0	-8.7
8) Gas Guzzler Tax – Moderate Case	-40,799	-6,058	-13,604	5,224	-8,609	-39,791	47,586	-25,546
% Diff.....	-1.5	-1.2	-4.9	9.2	-12.7	-4.1	8.5	-11.8

TABLE 7

Energy Summary for GST Moderate Case

(Differences from Reference Case)

	YEARS				%CH 1990 TO
	1990	1995	2000	2005	2005
New Energy Taxes($ Millions)	0	2,546	4,009	5,954	NC
Heavy Fuel Oil Price ($1990/BBL)	20	26	33	41	5.0
Difference	0	0	0	0	38.0
Motor Gasoline Price(1990 Cents/Litre)	55	59	67	81	2.6
Difference	0	0	0	0	25.5
Natural Gas Price ($1990/GJ)	3	4	5	7	5.9
Difference	0	0	0	0	NM
Coal Price ($1990/GJ)	2	2	2	2	1.3
Difference	0	0	0	0	NM
Electricity Price ($1990/GJ)	10	12	13	13	1.6
Difference	0	1	1	1	NM
Motor Vehicle Sales (Thousands)	1,439	1,693	1,790	1,906	1.9
Difference	1	-31	-10	-7	NM
Compact Car Sales (Thousands)	650	755	801	924	2.4
Difference	0	-24	-9	-5	NM
Total Kilometres Traveled (Millions)	245,609	276,283	303,913	324,894	1.9
Difference	-5	-3,771	-5,353	-6,338	-60.7
Nuclear Capacity (Megawatts)	12,369	15,969	15,947	17,747	2.4
Difference	0	0	0	900	NC
Natural Gas Demand (Petajoules)	2,948	3,419	3,602	3,718	1.6
Difference	-3	-16	-22	-39	-19.6
Electricity Demand (Petajoules)	1,742	1,967	2,170	2,318	1.9
Difference	7	-51	-88	-156	NM
Petroleum Demand (Petajoules)	3,608	3,745	3,890	3,844	0.4
Difference	-3	-40	-38	-75	-25.0
Motor Gasoline Demand (Petajoules)	1,195	1,222	1,252	1,247	0.3
Difference	0	-12	-17	-20	-50.3
Road Diesel Demand (Petajoules)	335	417	469	494	2.6
Difference	0	-4	-4	-6	-22.9