

# Counting the Costs:



Effects of  
the Federal  
Kyoto Strategy  
on Canadian  
Households

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The CTF's three-fold mission statement is:

1. To act as a watchdog on government spending and to inform taxpayers of governments' impact on their economic well-being;
2. To promote responsible fiscal and democratic reforms, and to advocate the common interest of taxpayers; and
3. To mobilize taxpayers to exercise their democratic responsibilities.

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CTF offices field hundreds of media interviews each month, hold press conferences and issue regular news releases, commentaries and publications to advocate the common interest of taxpayers. The CTF's official publication, *The Taxpayer* magazine, is published six times a year. CTF offices also send out weekly *Let's Talk Taxes* commentaries to more than 800 media outlets and personalities nationally.

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# Counting The Costs: The Effects of the Federal Kyoto Strategy on Canadian Households

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## Summary

The expert literature on the costs of Kyoto, including analyses done by and for the federal government, shows that Canadians can expect implementation of Kyoto to be very costly. Based on a planning document released October 24, 2002, the federal government is looking at a proliferation of regulation-intensive policies that will cost a lot and do little.

For instance, in speeches and advertising they are focusing on household energy efficiency measures like “turning down the thermostat” or doing the laundry in cold water. They estimate these measures would yield 0.4 Megatonnes of reductions. But the overall target the government has committed to is 240 Megatonnes: *600 times larger*. Clearly, public relations campaigns to get people to save energy are irrelevant to the discussion of how to meet the Kyoto target. Kyoto ultimately means a fundamental restructuring of the economy.

If the Kyoto target is going to be met, there will have to be substantial changes in consumption driven by large energy price increases via taxes, tradable permits or cost pass-throughs from new regulations on industries and households. Canadians will experience a higher cost of living and lower real incomes.

Previous analyses have shown that once these measures start to bite, the price of natural gas could go up more than 90 percent, while the price of gasoline at the pump could rise by about 50 percent (or 30 to 35 cents per litre).

The combination of price increases and wage reductions that will eventually be necessary will reduce annual real after-tax household income by about \$2,700 as of 2010. This is an extremely costly policy, especially in light of the fact that it yields no economic or environmental benefits.

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## **INTRODUCTION**

In 1997 the government of Canada signed the Kyoto Protocol, which if ratified will require Canada to cap emissions of carbon dioxide at 6 percent below 1990 levels. The deadline is 2008-2012, meaning that average emissions over this interval must be at or below the target.

Carbon dioxide (CO<sub>2</sub>) is not an air contaminant. It is a colourless, odourless gas that is naturally present in the atmosphere. CO<sub>2</sub> emissions do not cause smog or acid rain, nor do they cause breathing problems or other health difficulties. Indeed CO<sub>2</sub> is a natural part of human respiration. It puts the fizz in your pop and the bubbles in your beer. Reducing CO<sub>2</sub> emissions will not, for instance, reduce the number of smog days or the density of urban haze. It is not covered by provincial air pollution control regulations, nor is there any reason for it to be.

It is being considered for controls now because some scientists have argued that releasing carbon dioxide into the atmosphere can cause changes in the Earth's climate system. The evidence on this point is quite inconclusive: see *Taken By Storm, the Troubled Science, Policy and Politics of Global Warming* by Christopher Essex and Ross McKittrick (Key Porter Books, 2002, [www.takenbystorm.info](http://www.takenbystorm.info)). However, based on conclusions in summary documents by a UN-sponsored panel in 1996 and 2001, the Government of Canada decided to go ahead and commit to the Kyoto emissions reduction target.

It should be stressed that Kyoto is a *target*, but not a *plan*. It is like committing to go from Toronto to Vancouver, without knowing how you will get there. It is possible to make the trip at a modest cost, but it can also cost a great deal. Kyoto is, likewise, a destination, and the ideas for getting there are potentially very expensive.

Since Kyoto was signed the federal government has provided Canadians with no independent review of the scientific rationale and no detailed implementation plan or independent cost estimates.

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There have been some closed-door consultations but no public hearings on any of these matters. Many observers suspected the federal government did not intend to proceed with ratification of Kyoto. But in September 2002 the Prime Minister unexpectedly announced that he would seek ratification of Kyoto by the end of the year.

A federal Discussion Paper released in April 2002 was supposed to set out the government's strategy, but in the end contained too little detail to be useful. It was extensively analyzed and critiqued in a C.D. Howe Institute study released in October 2002, called "The Kyoto Protocol: Canada's Risky Rush to Judgment" by Ross McKittrick and Randall Wigle. We concluded that the measures being proposed are not even remotely cost-effective, most are infeasible and the cost analysis is inadequate for supporting a debate of this kind.

The government held a series of by-invitation-only consultations on their Discussion Paper over the summer, and in the end abandoned the four options it set out. Then on October 24 they released a new draft plan. This one has even less detail in it than the previous ones. It is a blend of elements from previous plans, leaves 25% of the required emission reductions unaccounted for, and includes no economic cost estimates. On this basis they are now seeking approval from Parliament for rapid ratification.

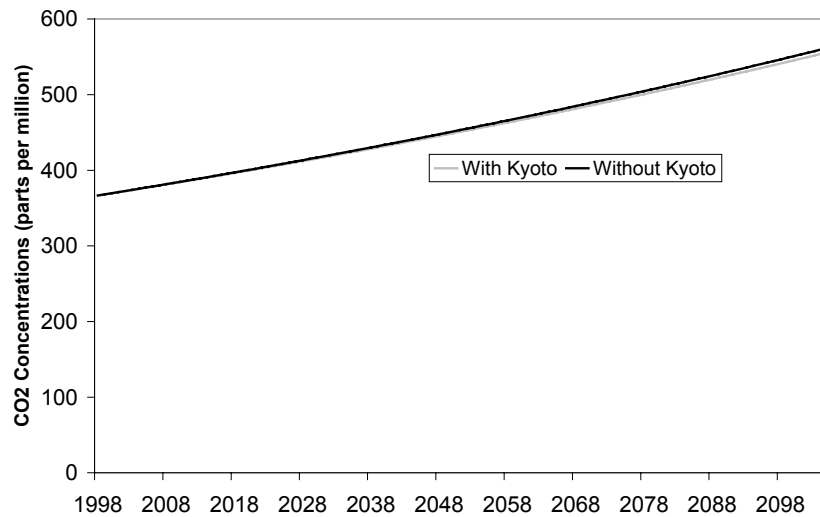
Complicating the picture for Canada is the fact that all our major trading partners face lighter targets or no targets at all. First of all, neither Mexico nor the United States is bound by Kyoto. The US has rejected the treaty, while Mexico is exempt from emission reduction requirements because it is a developing nation. This means that our NAFTA partners, accounting for over 90 percent of our international trade, do not face the Kyoto burden. Japan has ratified Kyoto but is not imposing any emission reduction requirements on its industries and is unlikely to meet its targets. Australia has pulled out of the treaty. India and China (which will be the major source of emissions growth over the next century) are exempt because they are developing countries.

The Europeans are still in, but their target is only about one-third the size (in percentage terms) of Canada's. Emissions are compared to 1990 levels. At that time, the UK was

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closing down many old, uneconomic coal pits, and the power stations that used the coal were converted to use North Sea natural gas. In Germany meanwhile, reunification after the 1990 collapse of the Soviet Union brought a lot of money-losing, coal-intensive firms into the German economy. As they have been shut down for business reasons total emissions have fallen. Since the European target is continent-wide the emission reductions in the UK and Germany help ease the burden for other EU countries.

Because so few countries are participating, the environmental benefits of the treaty are nonexistent. Figure 1 shows a projection of the atmospheric carbon dioxide content with and without Kyoto for the next 100 years (see Appendix A for details). Given the fact that CO<sub>2</sub> is not an air pollutant, and has only a minor and doubtful role in climate, the practical benefit of Kyoto is nil.



**Figure 1: Atmospheric CO<sub>2</sub> concentrations (parts per million) over the next century with and without Kyoto.**

## **COST ESTIMATES**

The federal government estimates that by 2010 Canada will emit about 809 Megatonnes (MT) of CO<sub>2</sub>, but the Kyoto cap is 571 MT. So the gap that must be covered is 240 MT, which equals about 30 percent of projected 2010 emissions. CO<sub>2</sub> is more difficult to control than other air contaminants like smoke and sulphur dioxide. These can be treated by improving the efficiency of the burning equipment or installing filters on a smoke stack. Carbon dioxide is released in proportion to the amount of fuel used regardless of the efficiency of the burn, and cannot be filtered out of the smoke stream. The only way to reduce emissions is to reduce fuel use or switch to fuel types with less carbon dioxide.

Reductions of the magnitude called for will involve significant changes in lifestyle. For instance, the federal government is currently focusing its advertising campaign on proposals such as “turning down the thermostat” and doing laundry in cold water. But their own estimates (released October 24, 2002) show that even if all Canadians implemented a suite of such household-level energy efficiency measures it would only reduce emissions by 0.4 Megatonnes.<sup>1</sup> The Kyoto target, as mentioned, is 240 Megatonnes: 600 times larger! Another policy the federal government has proposed is to require 20% of Canadian homeowners to retrofit their houses (replace the windows and insulation). The cost, disruption and time loss associated with this would be considerable, yet the expected emission reduction is only 1.5 Megatonnes: or 0.6 percent of the government’s Kyoto target.

Clearly, public relations campaigns to get people to save energy by caulking, or even replacing, their windows, are irrelevant to the discussion of how to meet the Kyoto target. Eventually there will have to be substantial price-based incentives, using either taxes, tradable permits or cost pass-through from new regulations on industries. Preferences for energy consumption are very stable. In a country like Canada where we have long distances to travel and large heating costs in the winter it is to be expected that people will not easily change their fuel consumption patterns.

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<sup>1</sup> 1 Megatonne equals 1,000,000 tonnes.



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The Kyoto target, however, requires that Canadian households and firms reduce fuel consumption by a large amount. Long experience with failed energy efficiency policies in the 1970s and 1980s, and futile “demand-side management” policies on the part of public utilities in the 1990s, has shown that the only way to make this happen is to substantially and permanently increase the price of fuels paid by firms and consumers.

Studies looking at the costs of carbon dioxide emission reductions were done or commissioned by Finance Canada, Environment Canada and others in the 1990s. These primarily looked at emissions control using a “carbon tax”: a charge placed on fossil fuels based on the carbon dioxide released when the fuel is burned. This is the easiest way to reduce energy consumption: by directly forcing up the costs through a new tax. The Government of Canada has been emphatic for many years that it will not use a carbon tax as part of its emissions control package. But these studies have found that even small changes in the way the emissions target is achieved can have big impacts on the overall costs of the emissions target. Consequently carbon tax studies need to be interpreted carefully to get guidance about how much the current approach to Kyoto will cost.

Other studies done since 1997 include a report for Industry Canada by Wilfrid Laurier economist Randy Wigle and the reports (2001, 2002) of the federal Climate Change Secretariat’s Analysis and Modeling Group.

Professor Wigle’s Report found that the costs of complying with Kyoto would depend critically on whether Canada can buy “emission credits” on the international market. If not, the costs could rise to about seven percent of GDP annually (about \$85 billion at the end of this decade) depending on how the domestic emission reductions burden were shared among industries. If foreign permits are available at a low cost rather than relying on domestic emissions abatement we could buy credits from other countries. This approach leads to cost estimates in the low range, usually about 0.5 percent of GDP annually. Of course this is not “low” in a dollar sense, since it represents \$6 billion in a \$1.2 trillion dollar economy. This would be the annual cost, at the start of the policy (about 2008).

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Emission credits are certificates that allows the holder to emit a unit (e.g. one tonne) of carbon dioxide into the atmosphere. If a country which has joined Kyoto achieves an emissions level below its target it will thereby gain credits which can be sold to other countries. If Canada purchases a credit from another country, we are taking it on trust that the country actually achieved the emissions reduction it claims to have achieved. A key problem with the permits-trading idea is that, among Kyoto participants, only Russia and the Ukraine expect to be in a position to sell significant numbers of credits. But because of the collapse of the Soviet government and economy in the early 1990s there are no legal institutions to provide remedy to Canadian buyer if the credits turn out to be bogus. There are, indeed, many significant legal and political obstacles to a smoothly-functioning international credits-trading system. This point was explored in David Victor's book *The Collapse of the Kyoto Protocol and the Struggle to Slow Global Warming* (Princeton University Press 2001).

The federal government has not formally investigated what institutions need to form before an international emissions permit system can be developed. Since the costs of Kyoto implementation depend so critically on whether the international emissions credit market comes into existence, it is essential to understand the nature of this risk before committing ourselves to potentially billions of dollars in new liabilities under a Kyoto emissions credit trading system. This is only one of many serious omissions in the federal analysis behind Kyoto.

The policy packages currently under consideration (which were released last April by the federal government) envision private firms buying tens of millions of emission credits from foreign sellers, at a minimum of \$10 per tonne. At present the Canadian government seems ready to commit to Kyoto on the expectation that private firms will be willing to pay over \$100 million annually to buy emission credit certificates from Russian firms or the Russian government, with no mechanisms for auditing the validity of those credits and little ability to seek financial remedy if they are bogus.

## **THE RANGE OF COSTS**

There are three main assumptions that need to be considered in order to understand the range of estimates that are relevant for figuring out the cost of Kyoto to Canadians.

- ***Whether international permits are available***

If international permits are available at a low cost, this reduces the burden of Kyoto because rather than doing domestic emission reductions Canada buys all the permits we need on the foreign market. The cost would be borne by whomever purchases them, which might be private firms or the government. In the C.D. Howe Institute Commentary mentioned previously, we calculate that the minimum Kyoto could cost (given the federal government's own economic modeling results) is \$2.1 billion in the first year, which would rise every year after that.

As mentioned above there are serious impediments to the formation of an international permits-trading market. There is no precedent for such an institution, and the absence of stable legal institutions in Russia (the main source of permits) means permits may be printed up and offered, but because they cannot be audited they are worthless.

- ***Whether domestic tradable permits are auctioned or given away***

If international permits are not available there may still be scope for a domestic emissions trading system. The federal government would either auction emission permits or give them away and let firms trade them privately. The price in the case of a purely domestic market would be much higher than if an international market exists: about \$100 per tonne rather than \$10. A key question is whether the permits are auctioned or given away. Giving them away to emitters turns out to be much more costly for the economy as a whole since it effectively turns all the country's emitters into a cartel of permits-holders.

This was one of the chief differences between "Option 1" and "Option 3" in the federal government's Discussion Paper last Spring (as well, under Option 3 fewer firms participate in the market). Giving away permits rather than auctioning them means the

federal tax base shrinks and it must raise other taxes to keep revenue-neutrality, or cut other spending. The federal Discussion Paper estimated the total additional burden (from tax and price increases) from giving away permits rather than auctioning them to be between one and two percent of GDP (see the C.D. Howe Commentary, page 22) or \$1,000 to \$3,000 per person. This works out to between \$2,400 and \$7,200 per household.

The federal government did consider an auction system under Option 1 in the Spring 2002 Discussion Paper, but they seem to have abandoned that idea. The current plan is to give permits away, despite the extra cost involved.

- ***Cost-efficiency of domestic emission reduction burden-sharing rule***

For the portion of Kyoto compliance that involves domestic emission reductions, the question of who does the cutting plays a big role in the aggregate cost. Some sources can reduce emissions at a fairly low cost, while for others the cost is much higher. It is comparatively more difficult to reduce carbon dioxide emissions from the motor vehicle transport sector than from the power generation sector, for instance, because emissions arise in small quantities from millions of sources.

Policies that offer flexibility, like tradable permits and carbon taxes, distribute the emission reduction burden in such a way as to minimize the total costs to society. But if the policy is implemented using command-and-control (or so-called “targeted”) measures, the economic costs can rise substantially. This happens because such policies inevitably place a greater burden on high-cost sources than would have a flexible, market-based instrument.

For instance, in his study for Industry Canada, Professor Wigle looked at the costs of giving certain industry groups a “break” on their targets. He found that, in a scenario focused on domestic emission reductions, giving exemptions to non energy-intensive sectors doubled the implementation costs, while exempting the energy-intensive sectors caused the aggregate costs to rise seven-fold.

Unfortunately we can say very little about the costs of measures currently being proposed since the federal government will not release its estimates. Professor Wigle and I requested them for our C.D. Howe Institute study and we were told they are “too uncertain to publish.” Consequently no one knows how high the costs of the mix of targeted measures currently under consideration will go.

However we can be quite certain that a cost-effective burden-sharing rule will not be found. Since only the large final emitters are expected to participate in any domestic emissions market, and the current Kyoto strategy includes a lot of the targeted measures presented last Spring, we know the total costs will exceed the estimates produced in the studies mentioned above, since they looked at implementation using carbon taxes or economy-wide tradable permits.

### **THE LIKELY COSTS TO CANADIAN HOUSEHOLDS OF IMPLEMENTING KYOTO**

The biggest challenge for figuring out the costs of Kyoto to Canadian households is that there is not presently a credible plan in place. There have been studies done previously of various policy packages and their costs, but those packages look nothing like the most recent federal options. The “plan” released in late October contains a suite of command-and-control measures that are quite different in their nature and potential impact, but there were no cost estimates provided. So the best we can do is pick another previous study that closely resembles the recently proposed options and adapt its estimates to the current situation.

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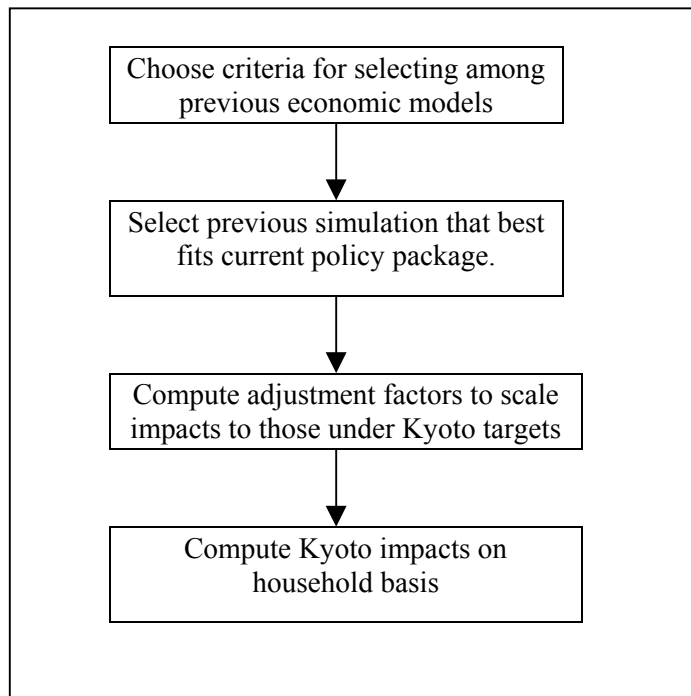


Figure 1 outlines the method followed for these numbers. Further details are given in Appendix B.

To convert the percent changes computed by the economic model into dollar costs, it was assumed that the economy will grow a total of 10 percent (real growth) between 2001 and 2010. According to Statistics Canada (Catalogue 13-001), in 2001 total nominal income was \$862.7 billion. Take away \$204.8 billion in direct and indirect taxes to yield net income of \$658 billion. If this grows by 10 percent over the decade real net income will be about \$724 billion as of 2010. There will be approximately 14.5 million households at that point, implying per-household net income will be, on average, \$49,912.

As shown in Table 1, this amount is expected to fall by 5.5 percent as a result of the price shocks needed to reach the Kyoto target. A reduction of 5.5 percent means a loss of \$2,745 per household, which is rounded down to \$2,700 in the Table. This would be a permanent loss, meaning it is felt every year Kyoto is in force. This is a loss in direct purchasing power, i.e. take-home pay after income taxes and after whatever amount is diverted to sales taxes and the GST.

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Total nominal private consumption (household spending on goods and services) in Canada was about \$620 billion in 2001. If this grows 10 percent it will be \$682 billion in 2010. This is projected to fall by 3.1 percent, which on a per-household basis is \$1,457. The drop in consumption is smaller than the drop in real income because people smooth their consumption by drawing down savings. This will have long term economic consequences as it retards investment and capital formation.

The model used for Table 1 computes a “general equilibrium,” which means there is no unemployment after the policy change. People do lose jobs in the transition period but they are assumed to find new jobs elsewhere or withdraw from the labour market. In these simulations about 1.5 percent of the workforce drop out of the labour market. In order to clear the remaining unemployment real wages must fall 5.8 percent. This leads to increases in employment in Services and Agriculture, which are relatively less energy-intensive, offsetting some of the job losses in Manufacturing and resource sectors. These offsetting job gains depend on reductions in real wages to clear the labour market.

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**Table 1:**  
**The Likely Annual Effects of Kyoto on Canadian Households**

| <b>COST ITEM</b>                   | <b>Percent Change</b> | <b>Dollar Cost per unit</b> | <b>Annual Total per Household</b> |
|------------------------------------|-----------------------|-----------------------------|-----------------------------------|
| <b>Carbon Dioxide Price</b>        |                       | \$31/tonne                  |                                   |
| <b>Energy Costs</b>                |                       |                             |                                   |
| Natural Gas                        | +93.9                 | \$0.18 /m <sup>3</sup>      | \$396.00                          |
| Coal                               | +261.0                | \$130.00 /short ton         |                                   |
| Refined Fuels                      | +48.3                 | \$0.34 /litre               | \$244.80                          |
| <b>Exports</b>                     | -10.9                 |                             |                                   |
| <b>Total Capital Employed</b>      | -3.8                  |                             |                                   |
| <b>Total Employment By Sector:</b> |                       |                             |                                   |
| Agriculture                        | +10.5                 |                             |                                   |
| Mines, Quarries,<br>and Oil Wells  | -7.1                  |                             |                                   |
| Refineries                         | -5.4                  |                             |                                   |
| Utilities                          | -3.1                  |                             |                                   |
| Manufacturing                      | -5.1                  |                             |                                   |
| Services                           | +0.6                  |                             |                                   |
| <b>Total Labour Employed</b>       | -1.5                  |                             |                                   |
| <b>Real Wage Rates</b>             | -5.8                  |                             |                                   |
| <b>Real Gross Domestic Product</b> | -2.7                  |                             |                                   |
| <b>Real Consumption</b>            | -3.1                  |                             | - \$1,457                         |
| <b>Real Net Income</b>             | -5.5                  |                             | - \$2,700                         |

The total annual dollar costs for the fuel price changes are based on the assumption of 2200 m<sup>3</sup> consumption of natural gas and 720 litres of fuel per household per year.



## **COMPARISON WITH FEDERAL ESTIMATES**

The estimated annual loss of \$2,700 in household net income seems, at first, to be quite high. But it turns out to be inside the range estimated by the federal government last Spring.

The current proposals for Kyoto resemble Option 3 in the Discussion Paper of April 2002. According to the federal modeling work, that plan causes per-person disposable income to fall between \$600 and \$1,500 by 2010 (see McKittrick and Wigle 2002, page 21). This is based on optimistic estimates about the feasibility of the package of targeted measures, and the easy availability of international permits for between \$10 and \$50 per tonne. Statistics Canada reports that there are 2.4 persons per household on average, implying a range of costs between \$1,440 and \$3,600. The estimate in Table 1 falls roughly in the middle of this range.

## **CONCLUSIONS**

While the federal government is currently proposing measures they believe will add little to the cost of using fuels, the history of “conservation” policies shows that without price incentives, consumption will not change much if at all. If the federal government expects to reach its Kyoto targets on the tight (5 year) timetable left to it, households will have to face heavy price shocks implemented through taxes, emission permits or other regulatory measures. Previous analyses have shown that once the required measures start to bite, the price of natural gas could go up more than 90 percent, while the price of gasoline at the pump could rise by about 50 percent (or 30 to 35 cents per litre). Based on my reading of the expert literature on the costs of Kyoto, including analysis work done by and for the federal government, Canadians can expect ratification of Kyoto to be very costly.

The combination of price increases and wage reductions will reduce annual real net household income by about \$2,700 annually once the agreement is in force. In light of the fact that Kyoto yields no economic or environmental benefits this is obviously a bad deal for Canadian households and should be rejected.

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## **APPENDIX A: DERIVATION OF FIGURE 1**

Atmospheric CO<sub>2</sub> concentrations are measured at an observatory at Mauna Loa, Hawaii. Since records began in 1959 concentrations have risen, on average, about 0.4% per year. Figure 1 shows, for a base case, concentrations continuing to grow at 0.4 percent annually.

The original form of the Kyoto Protocol, involving countries responsible for about 50 percent of world carbon dioxide emissions, would have yielded very little effect on the global atmospheric CO<sub>2</sub> concentration. Climate model simulations (Wigley 1998) showed Kyoto would yield about a 5 year delay in the date at which CO<sub>2</sub> levels double, if all parties complied fully and the agreement was held in force throughout the next century. However since then some important changes have occurred, including:

- The US has withdrawn, so the treaty now covers only about one-third of global emissions;
- Canada and others have been given credits for “sinks”, or pre-existing forests and grassland; and
- The Russian Federation has been given permission to sell its entire stock of “hot air” permits.

The result is that Kyoto will reduce global CO<sub>2</sub> emissions by about 6 percent: one-third of the original emission reduction (see McKittrick and Wigle 2002 page 6 for detailed calculations). The effect on the growth of global CO<sub>2</sub> concentrations will therefore be minuscule, as shown in Figure 1. That Figure shows the trajectory if the concentration reached in 2100 under business-as-usual is instead reached in 2003.

## **APPENDIX B: METHOD FOR COMPUTING HOUSEHOLD COSTS OF KYOTO**

To compute an estimate of the costs households will bear, I begin with figures drawn from the Computable General Equilibrium (CGE) simulations of McKittrick (1996). The particular methodological advantages of this study are: the model was econometrically-estimated using up-to-date data; it embodies a complete specification of responses to tax and price changes throughout intermediate and final demand sectors; it allows for full labour market responses and it allows for capital reallocation across sectors and internationally, thus showing the long-run economic impacts. The CGE simulations in Wigle (2001) and the AMG 2000 report (Chapter 6) each lack some or all of these features. The macroeconomic model used for the April discussion paper do not capture the equilibrium price responses of CGE models, which is important for studying large-scale economic restructuring as would be induced by Kyoto.

Within the suite of simulations in McKittrick (1996) the particular experiments discussed are the “DR” (deficit reduction) group, in which carbon dioxide tax revenue is applied to deficit reduction rather than reducing other tax rates. This is the closest form of the simulation to what is being proposed currently by Ottawa, since they are not auctioning permits.

The experiments in the 1996 report indicate that a tax of just under \$25 per tonne of CO<sub>2</sub> would yield a reduction of just over 20 percent in domestic emissions. The impact on domestic households is significant. Real consumption falls by 2.5 percent and household net income falls by 4.4 percent. Other studies have found that the required carbon dioxide tax would be much higher, going into the hundreds of dollars in some cases. But these studies typically do not account for the flight of capital from Canada in response to domestic application of Kyoto-like targets. In my model this reduced the required magnitude of the carbon dioxide tax. About 3 percent of the nation’s capital stock exits the country due to the imposition of emission-reduction policy in Canada but not in the US. So owners of capital are able to maintain their income by moving their assets out of the country. Those who depend solely on labour income cannot. This makes the distributional consequences of the policy troublesome.

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The Effects of the Federal Kyoto Options on Canadian Households

To re-scale these results to the current debate, I note first that the target in my 1996 study was only 20.4 percent of emissions. Kyoto calls for a reduction of 30 percent, or 50 percent more. However Canada gets 24 Megatonnes in credits for land-based “carbon sinks,” i.e. forests and other greenspaces, so our final target will be more like 25 percent. If the carbon dioxide tax is scaled up an equal proportion it becomes about \$31 per tonne.

This is in line with the low-end of carbon dioxide charges in models surveyed by Wigle (2001) in the presence of international permits trading. It is also in the middle of the range of permit prices (\$10-50) considered by the federal government in its current Kyoto discussions. Consequently the question of whether international permits are available or not is moot for this calculation. If they are available they will easily cost over \$30 per tonne, so having domestic action occur at that price without assuming the availability of permits does not exaggerate the economic effects.

The economic impacts do not scale up directly, but would be actually be amplified by aiming for a tighter target, since marginal costs of emission reductions rise. However, to keep the discussion simple I apply a linear scaling of  $(25/20 = 1.25)$ . Consequently the effects on households are as shown in Table 1.