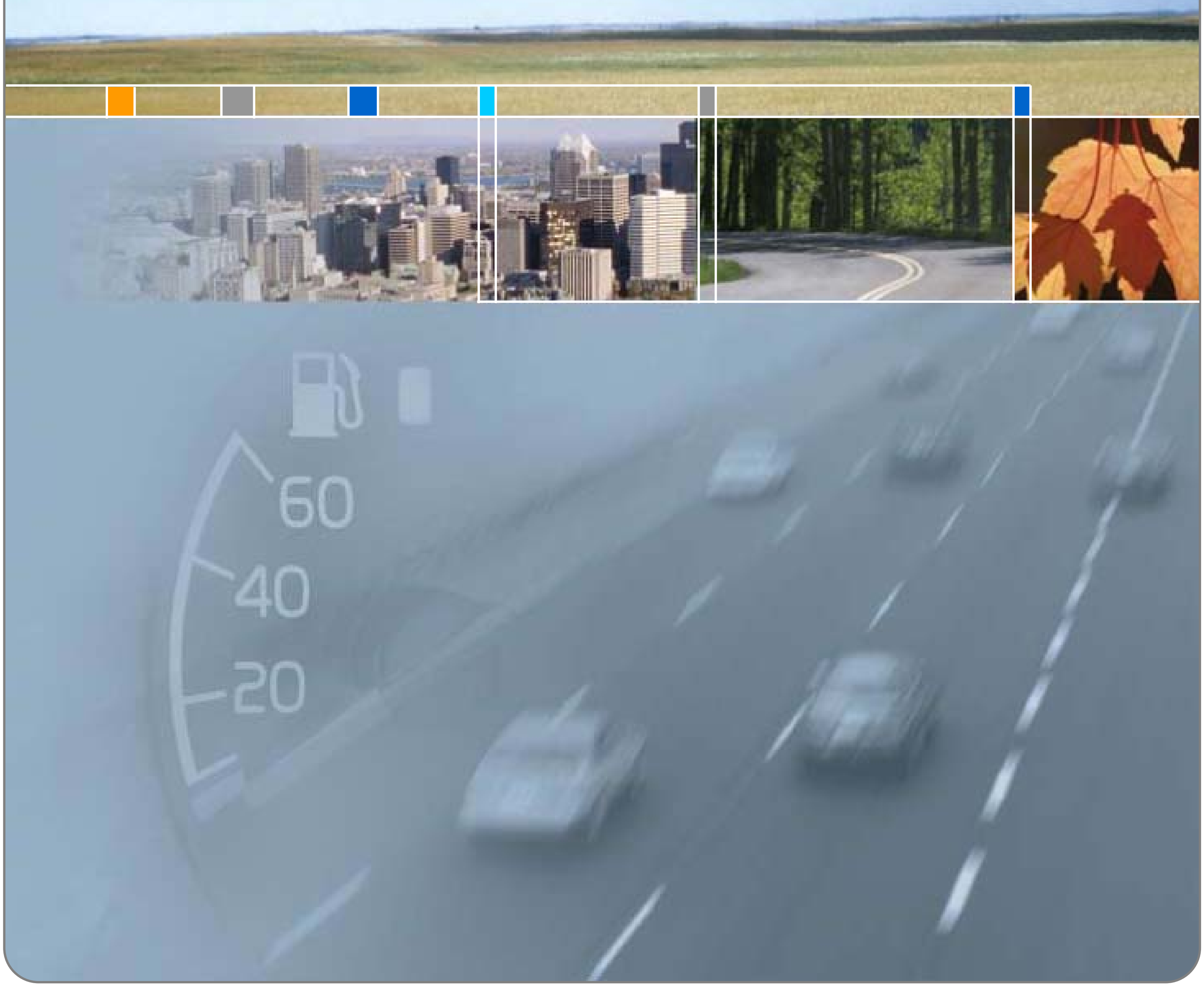
Government of Canada Gouvernement du Canada

A BETTER CANADA — A CLEANER ENVIRONMENT:

THE DEVELOPMENT OF MOTOR VEHICLE FUEL CONSUMPTION REGULATIONS

TECHNICAL DISCUSSION PAPER



February 8, 2008

Canada

INTRODUCTION

Over the past 30 years, Canada has had a voluntary policy for improvements in fuel consumption from cars and light trucks. In 2005, the vehicle suppliers signed a Memorandum of Understanding (MOU) to reduce greenhouse gas (GHG) emissions from cars and light trucks by 5.3 million tones in 2010. Despite some improvements in fuel consumption and emissions control technology achieved through these voluntary policies, total fuel consumed and GHG emissions have risen substantially over the last two decades. For this reason, the Government of Canada (GoC) has announced its intent to regulate the fuel consumption of motor vehicles under the authority of the *Motor Vehicle Fuel Consumption Standards Act* (MVFCSA) starting with the 2011 model year.

In the United States (U.S.), regulated Corporate Average Fuel Economy (CAFE) standards have been in place since 1975, but had most of their effect within the first decade. These standards were changed only by minor increments in the last two decades. Recently, however, a number of legislative proposals for more stringent federal standards were considered in the U.S. After much debate, the Democrat-led Congress agreed upon a bipartisan target of unprecedented stringency for 2020, and passed the Energy Independence and Security Act, which was signed into law by President Bush on December 19, 2007. The Energy Act amends the CAFE legislation by requiring standards to be set from model year 2011, sufficient to achieve an average among new vehicles in 2020 of 35 miles per gallon (6.7 litres per 100 kilometre). As of the release date of this paper, no further announcements had been made of the process and schedule to be followed by the U.S. Department of Transportation (DOT) in setting the annual standards needed to achieve this goal.

The U.S. goal of 35 miles per gallon in 2020 provides an ambitious benchmark for fuel efficiency standards. With the customary choices by Canadians of a more fuel-efficient mix of vehicles than the U.S. (including a higher proportion of cars versus light trucks), adoption by Canada of the same size-based standards as those being developed in the U.S. would result in actual Canadian fleet performance better than that in the U.S. If the standards achieve 35 miles per gallon (6.7 litres per 100 kilometre) in 2020 in the U.S., they would achieve better than that in Canada. As such, in January 2008, the GoC announced its intention to develop regulations prescribing standards at least as stringent as those in the U.S.

To evaluate options for Canadian standards, the GoC will analyze the U.S. federal proposals, and reasonable and practical alternatives. The standards proposed by California will also be analyzed for comparative purposes. The evaluation will forecast the effects the standards would have on vehicles sold in Canada. From the changes expected in technologies, the effects on fuel consumption performance of the Canadian fleet will be estimated. An economic analysis of the proposed regulations will be undertaken, in accordance with Federal Government procedures. This will include an analysis of costs imposed on suppliers and users of vehicles, and of the benefits in fuel savings, together with the social values of reductions in emissions, and any effects on safety. The effects on total output and employment in the economy will also be considered, and their distributions by regions and sectors.

The purpose of this Technical Discussion Paper is to provide stakeholders with the information they need to understand the Government's analytical methodology and submit comments on this important issue.

COST-BENEFIT ANALYSIS

Cost-benefit analysis is recognized in official government practice in Canada and many other countries as the standard method of assessing government regulatory programs, as well as investments in public sector projects. It is supported by a long history of academic research into its concepts and methods, and decades of practice. It is similar in nature to analyses in the private sector of the financial returns to be expected from an investment in a new construction project or production process – indeed, the core of a government program assessment will usually be a projection of the financial costs and returns to be expected. Key differences are that:

- The government analysis deals with the effects wherever and to whomever they occur, recognizing that costs may be borne by some companies or individuals in society and benefits gained by others; the government assessment will combine all these effects, and consider their balance, to see if there is a "net benefit;"
- The government is interested in more than the money flows; it also assesses the gains and losses from a regulation that have no obvious market values, or for which market values reflect only inadequately their values to the wider society – their "social values." Examples of such gains or losses include aspects of health, safety and protection of the environment, which have become the objects of a great deal of government regulation in recent decades, and to which policies requiring formalized assessments of costs and benefits have been particularly addressed. Public sector analysis – so-called "social" cost-benefit analysis – attempts to infer monetary values for non-marketed costs and benefits, or to adjust market values to reflect social values, and otherwise to take into account dimensions of social gains or losses that defy monetization.

Canada's regulatory policy requires that evaluations be undertaken for major regulations, and published in a Regulatory Impact Analyses Statement (RIAS) with the regulatory proposals in Part I of the Canada Gazette. The Treasury Board Secretariat (TBS) provides guidance to departments on how to prepare a RIAS. The TBS document includes the following guidance for analysts on the content of a RIAS:

Benefits and costs

It must be demonstrated that the regulatory proposal maximises the net benefit for Canadian society. This entails a demonstration that:

- The benefits of the regulation outweigh the costs to Canadians;
- The regulatory program is structured in such a way that the difference between the benefits and costs is the greatest possible; and
- The net benefits of the chosen regulatory action are greater than the net benefits accruing from any other regulatory or non-regulatory alternative.

All regulatory proposals must undergo a cost/benefit analysis. This is used to assess the gains and losses resulting from alternative regulatory and non-regulatory actions to help departments decide whether any of the actions should be undertaken. In carrying out the analysis, four questions must be addressed:

1. What will change as the result of the introduction and operation of each proposed action?
2. What is the estimated value of the benefits that will come about as a result of each proposed action, and who will obtain them?
3. What are the estimated costs of each proposed action, and who will pay them?
4. Given the estimated benefits and costs, should any of the proposed actions be undertaken and, if so, which one?

While the first three questions may appear to be largely technical in nature, inevitably some judgement will be required. Often, it will not prove possible to quantify all the effects of all proposed actions. Generally speaking, analysts take a broad view of both benefits and costs. Addressing question 4 will normally require even more judgement. If the department or agency responsible for the analysis decides to proceed with a regulatory proposal, it must make the case in the RIAS that the benefits of the recommended option outweigh (or justify) the costs, and also that the recommended option is the best one. They must base their argument on the analysis presented in the document, which should be clear.

The impact assessment should assess:

- The economic, social, environmental and health impacts of the proposal on Canadian society;

- The distributional impacts (fairness and equity implications) of the proposal. For example, will the proposal have a disproportionate impact on an industrial sector, area or identifiable social group (e.g., First Nations)?

- The impacts that may affect a region, business and trade, and competitiveness. For example, will a proposal impede competition or promote it?

The cost-benefit analysis of options for Canadian fuel consumption standards will aim to quantify the social costs and benefits, estimate their monetary values, and compare them to assess whether they provide a net social benefit.

The standards are expected to be specified as a function relating fuel consumption to a vehicle attribute like footprint. The analysis that determines these targets will identify the changes in vehicle technologies that would be needed to achieve the standards.

BASELINE FORECAST

The cost-benefit analysis will be undertaken for the "cohort" of vehicles to be affected by the regulations – i.e. the group of vehicles to be sold in the affected model years. It will estimate the "baseline" fuel consumption and emissions of these vehicles over their expected lives, and compare that to their lifetime fuel consumption and emissions expected as a consequence of the regulations. The baseline forecast will be created from product plans identifying the technologies to be available in each vehicle make-model, or "nameplate", and the expected sales of each. The product plans are expected to be obtained directly from manufacturers, or from independent sources, including a study of potential fuel-saving technologies. The analytical modelling to be undertaken will then estimate how each standards option could be achieved by applying the available technologies, in order of their cost-effectiveness. For each standards option, the resulting fleet fuel consumption and emissions will be forecast over their lifetimes. The incremental costs of the technologies will be estimated, together with the value of fuel savings and the values of relevant changes in other social effects.

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The baseline "business-as-usual" forecast will aim for consistency with the forecasts of vehicle sales and energy use in the most recent version of *Canada's Energy Outlook* [1], based on its assumptions of population, general economic activity, and fuel prices.

An analysis of the effects on the overall fleet of light-duty vehicles, its use, fuel consumption and emissions will also be made, using a model of the vehicle fleet and its use, adapted from existing GoC models, including the model that is now being developed to monitor progress under the MOU on vehicle GHG emissions.

Forecasts will also be included of the use of alternate fuels, and changes to air conditioner technology and usage, which would further modify average vehicle fuel consumption.

1 The most recent version is Natural Resources Canada: Canada's Energy Outlook: The Reference Case 2006

TECHNOLOGY COSTS

The capital costs to manufacturers of applying each of the technologies and combinations of them will be estimated from a number of sources. For many of the technologies expected to be included, there already exist published estimates from independent analyses, notably in the report of the U.S National Academy of Sciences (NAS) from 2002, and that of the Northeast States Center for a Clean Air Future (NESCCAF) of 2004. Transport Canada (TC) also commissioned two studies from Energy and Environmental Analysis Inc., in 2005 [2] and 2006 [3]. These supplemented the NAS assessments with newer information and revised "cost curves" (functions describing incremental costs for achievable reductions in fuel consumption or GHG emissions). Importantly, the latest study added assessments of diesel and hybrid technologies, not included by the NAS. It also gave some consideration to the issue of whether adoption of technologies for vehicles sold in Canada that were not required under U.S. federal regulations would lead to higher costs.

A new assessment of technologies and their effectiveness and costs is underway by the U.S. NAS [4]. The study is due for completion in July 2008, and any results that become available in time for the Canadian analysis will be incorporated. The GoC will assess all available evidence on technologies and costs, and address further the relationships between production volumes and costs, and likely costs of technologies adopted only for sales in Canada.

Maintenance cost increases arising through the new technologies will also be considered. The major recent assessments, including the evaluations by DOT of the 2008-11 light truck standards, and by NESCCAF/California Air Resources Board of standards to 2016, have concluded that maintenance costs should not increase as a result of the new technologies (with the minor exception in the DOT assessment of increased battery maintenance if 42-volt systems were adopted). The issue will be reviewed for the assessment of Canadian standards.

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2 Energy and Environmental Analysis Inc.: "Automotive Technology Cost and Benefit Estimates," prepared for Transport Canada, March 2005.
3 Energy and Environmental Analysis Inc.: "Technologies to Reduce GHG Emissions from Light-Duty Vehicles," prepared for Transport Canada, June 2006.
4 See http://www8.nationalacademies.org/cp/projectview.aspx?key=48843

LIFETIME COMPARISON OF COSTS AND BENEFITS OF VEHICLES BY MODEL YEAR

The prime cost-benefit comparison will be of costs and benefits over the lifetimes of the relevant cohorts of vehicles. The standards will induce technology changes in vehicles, initially raising vehicle capital costs, after which the benefits will arise primarily as reductions in fuel consumption throughout the lifetime use of the vehicles. Motorists' maintenance costs may also increase at various stages of the vehicle lifetimes. There probably will be a rebound effect of increased fuel-efficiency: motorists will drive more because of their reduced fuel costs per kilometre (km). The consequent changes in fuel consumption and fuel types, from the technology changes and the rebound effect, will affect air pollutant emissions among the vehicles concerned. The change in vehicle-kilometres from the rebound effect might also increase congestion, accidents (if risks remain unchanged), and noise.

All of these effects will be represented as streams of costs and benefits over the lifetimes of the affected vehicles – that is, the vehicles of the types and model years affected by the standards. The relevant lifetime will be estimated from analysis of survival rates. They will be combined with the estimated average kilometres by age of surviving vehicles, to provide a profile of average lifetime expectation of kilometres driven. The rebound effect will be taken into account as increases in the kilometres by age of the vehicle. The final profile of kilometres by age will allow the GoC to estimate profiles of fuel savings, changes in air pollutant emissions, congestion, accidents and noise, and any changes in maintenance costs, by applying the relevant incremental rates per kilometre of each of those quantities.

Monetary values of the incremental changes will then be applied.

Finally, the lifetime profiles of incremental costs and benefits for the affected vehicles will be converted to equivalent present values, by discounting them to the same year [5]. Comparison of the present values of the costs and benefits will show whether the proposals would produce a net benefit.

It is expected that the comparisons will be made separately for vehicles of each model year affected by the standards, and for vehicles of all the relevant model years in combination. The latter will also allow a comparison of the baseline forecast for the entire fleet with a forecast of the fleet including all the changes invoked by the standards. It will be possible, for example, to show the absolute and proportional changes to be expected in annual vehicle- kilometres, fuel consumption, GHG emissions and air pollutant emissions.

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5 The equivalent values should be compared in any year, by discounting to that year, with their proportional relationships staying the same. But the easiest to understand would be either the year od analysis – i.e. 2008 – or the year immediately before implementation – say 2010.

KEY ANALYTICAL ASSUMPTIONS AND VALUATIONS

The following sections describe the main assumptions the GoC will use to model the vehicle fleet and to conduct the economic analysis of the effects of the standards, including the monetary values for the non-marketed effects, and other adjustments to social values of costs and benefits. As mentioned, the cost-benefit analysis will attempt to quantify, and provide monetary values for, all the effects produced by the standards. Those expected to be significant are considered, though it is possible that others will emerge through the consultations and analyses. As the recent analyses of U.S. light truck standards and Californian GHG standards are so prominent, some of their methods and assumptions are compared to those the GoC expects to apply for the Canadian assessment.

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DISCOUNT RATE

In the mid-1970s, the TBS provided guidance on the discount rate to be used in Canadian federal cost-benefit analyses. The rate was estimated, based on the rates of return on private capital and private savings to be in the range of 5% -15% per annum (p.a.). TBS recommended a central rate of 10%, with sensitivity analyses using 5% and 15%. That guidance was reaffirmed from time to time in TBS advice to departments on cost-benefit analyses and regulatory analyses [6]. A recent reassessment has essentially confirmed the conceptual basis of the discount rate, and endorsed a revised estimate of the central rate as 8% per year [7].

Among economists, there is considerable disagreement over the appropriate discount rate to be used in evaluations of this type of program. There are essentially two reasons for this. First, there are different concepts that might be applied in differing circumstances. Second, different organizations or analysts have followed substantially different practices in conducting evaluations, or they have differed over time even within the same agency. A major difference in concept exists between rates representing the social opportunity cost of capital and social time preference, the former reflecting the value in alternative uses of the resources used by an investment or program, and the latter reflecting preferences of individuals acting collectively between consumption of goods or services at different times. Estimates of the social opportunity cost rate are usually much higher (typically 7-15% recently) than those of the social time preference rate (typically 1-5%).

TBS guidance essentially represented the social opportunity cost of capital, weighted to reflect different sources of investment capital in the country. In its reaffirmation of the rate in 1998, the Treasury Board Guide considered carefully the arguments in favour of discounting using a social time preference rate, particularly for distant benefits in health or environmental improvement. It cited evidence from more recent academic research suggesting that those evaluating government programs should combine the concepts. This would be done by weighting capital costs by a "shadow price" representing the opportunity costs, and then discounting benefits to consumers by a social time preference rate. However, it found that the shadow price weights were even more difficult to establish than discount rates, and argued that a typical weight combined with a typical social time preference discount rate would give a result similar to that of the current social opportunity cost discount rate. TBS therefore recommended continued use of the same range of rates. It also emphasized that use of a social time preference rate alone, without weighting the costs of investments to reflect their opportunity costs, is incorrect [8].

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6 See TBS: *Benefit-Cost Analysis Guide for Regulatory Programs*, prepared by Consulting & Audit Canada, august 1995; and TBS: *Benefit-Cost Analysis Guide*, July 1998 (described as "draft" but released on the TBS website at http://www.tbs-sct.gc.ca/fin/sigs/Revolving_Funds/bcag/BCA2_e.asp).

7 See: TBS: *Canadian Cost-Benefit Analysis Guide, Regulatory Proposals*, Final draft July 1, 2007, at http://www.regulation.gc.ca/documents/gl-ld/analys/analys00-eng.asp

8 See the 1998 TBS Guide, op cit. The relevant concepts are also discussed in relation to Canadian federal evaluation practices for example in Lawson, J: "Procedures for 'discounting' future values in economic evaluations", Transport Canada Report TP 10567, 1998, and its revised version published in Transportation Associations of Canada Benefit-Cost Symposium, February/March 2001.

The debate over discount rates has also been reflected in U.S. Government guidance on cost-benefit analysis of regulations, which was followed by DOT in its analysis of the light truck standard. In 1996 [9], the U.S. Office of Management and Budget (OMB) conducted a similar review of the conceptual validity of the combined shadow pricing of capital and discounting using an opportunity cost rate. It recognized the impracticality of this and therefore recommended a rate (7%) reflecting the opportunity cost of capital. DOT's analysis of the 2005-07 light truck standards used that rate. Current OMB guidance extends the interpretation, recommending 7% as the "default rate." It also, however, suggests that when a regulation "primarily and directly" affects private consumption, the appropriate rate is a private return on savings, which it suggests as 3% [10]. Therefore, it recommends using both 3% and 7% for regulatory analyses affecting both industry and consumers. DOT followed this in its assessment of the 2008-11 light truck standards.

In conducting its analysis of Canadian standards, TC will follow TBS guidance. It will use an 8% rate as the central assumption, but also repeat the analysis at higher and lower rates to reveal the sensitivity of the results to the chosen rate.

A different application of discounting might also be necessary in the Canadian analysis if it applies the same method in designing an attribute-based standard as did DOT in designing the footprint standard. DOT applied a discount rate in its assessment of the "effective costs" of the various potential technologies available to manufacturers. In the U.S analysis, it was assumed that manufacturers would incorporate new technologies if their costs were less than the savings to purchasers through reduced fuel costs [11]. Effectively, DOT assumed that manufacturers could raise vehicles prices to cover the costs of the new technologies, without losing sales, if purchasers foresaw fuel savings higher than the vehicle price increases. To take account of how vehicle purchasers calculate fuel savings, DOT further assumed that purchasers would consider only the fuel savings over the first 4.5 years of a vehicle's life (the average period a new vehicle buyer keeps a vehicle), discounted at a rate of 7% per year. The department judged the 7% rate as approximating the rate at which consumers can finance vehicle purchases, and it was only coincidentally the same as the OMB-recommended discount rate for regulatory cost-benefit analyses.

There has been extensive research on consumers' valuation of fuel savings, much of it directed at estimating, based on actual purchasing behaviour, implicit discount rates and/or required payback periods. The results show large ranges of implicit rates, some substantially higher than DOT's 7%. The evidence will be reviewed and implications for the Canadian analysis considered.

9 U.S. OMB: "Economic Analysis of federal Regulations Under Executive Order 12866": January 11, 1996.
10 U.S. OMB: "Circular A-4 – Regulatory Analysis" September 2003.
11 The analysis took into account the alternative possibility of manufacturers paying CAFE fines; a further issue to be considered for our analysis in Canada, but not relevant to this consideration of discount rates.

REBOUND EFFECT

In assessing vehicle fuel-efficiency improvements researchers have long noted that there is a potential "rebound effect": motorists driving more when their fuel costs are reduced. This is referred to more formally and neutrally as the elasticity of vehicle-kilometres driven with respect to changes in the price of vehicle use. A recent review for the GoC of the evidence from studies in all energy-using sectors identified rebound rates as high as 50% (i.e. increased intensity of equipment or appliance use reduced by 50% the energy savings that would have resulted from the initial improvement in energy efficiency). Research evidence from 2004 on the rebound in vehicle use from increased fuel-efficiency showed rates between 10% and 30% [12]. The NAS analysis of Company Average Fuel Consumption (CAFC) effectiveness concluded the rebound was 10-20%. The U.S. analysis of light truck standards for 2005-07 originally used 15%, but raised the rate to 20% following objections by commentators. The U.S. light truck 2008-11 standards analysis also used 20%. However, the GoC review and the U.S. analysis of the latest light truck standards both recognized the new research by Small and Van Dender (for California's standards evaluation), which found much lower rebound values, and rates declining over time and with income [13]. The Small and Van Dender study had not been thoroughly peer-reviewed at that time, but has now been more extensively reviewed, and has gained further acceptance. It seems likely, therefore, that DOT will use lower estimates in evaluating the new U.S. proposals. The relevant rebound is projected to decline over time and as incomes rise. The California analysis estimated it to be only 3.08% in 2020. For the U.S. as a whole in 2011, it would be considerably less than 20% - possibly 10% or lower. The rate would be slightly higher in Canada, possibly by 1-2%, reflecting lower incomes.

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12 Lawson, J: "Investigation of some Aspects of the Response of Consumers to Economic Instruments to Reduce Motor Vehicle Fuel Consumption," Report by Research and Traffic Group to Transport Canada, March 2006.

13 See Small, K and Van Dender, K: "Fuel-Efficiency and Motor Vehicle Travel: The Declining Rebound Effect", Department of Economics, University of California, Irvine, Energy Journal, 2007.

TECHNOLOGY COST AND CONSUMER PRICES

The costs of potential technologies will be reviewed and updated, including all available evidence. Vehicle manufacturers' views will be sought in their responses to the requests for product plans.

The GoC will give particular attention to two issues in the review. The first is whether technologies might have different costs for vehicles sold in Canada than in the U.S., as estimated by U.S. analyses. The GoC assessment of potential technologies and costs will partially address this issue. The analysis in California will also be relevant: analysts there reduced the cost of some of the developing technologies by 30% below the independent estimates provided for the NESCCAF studies, on the expectation that full-scale production would allow higher cost reductions.

The other issue is the retail price mark-up between manufacturers' costs and consumer prices. The technology cost assessments normally estimate in detail the manufacturer's costs of equipment purchases and assembly, then apply a simple assumption of an average mark-up to retail price. In the NAS and NESCCAF studies, that mark-up was 40%, which was therefore used in the U.S. light truck standards assessment and California's GHG standards assessment. The rate was challenged by manufacturers as insufficient to cover such items as development costs, modifications to assembly processes and overheads.

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AVERAGE ON-ROAD FUEL CONSUMPTION VS TEST

In the modelling, fuel consumption rates in actual usage are necessary to estimate total fuel use. It is proposed that the average rate of consumption for vehicles of each affected class in each model year be calculated as the average of their CAFE test values on the urban (Federal Test Procedure) and highway cycles, degraded to reflect road rather than test conditions, and to remain constant over vehicle lifetime.

Projections will also be made of the use of alternate fuels in vehicles capable of using them, and of the average consumption rates by model year, modified according to any potential credit system that is selected.

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VALUE OF FUEL SAVED

The annual prices of relevant fuels will be forecast over the lifetimes of the affected vehicles, primarily based on Natural Resources Canada's Energy Outlook, though amended if better information becomes available following the recent experience of sustained prices above those forecasts.

For the estimation of social benefits from fuel savings, the "special" tax components of fuel tax will be removed, as they do not represent resource savings, but merely transfers between governments and consumers, with governments losing what consumers gain. "Special" tax components are those over and above normal sales taxes – i.e. over and above GST and PST/HST at normal rates, which would not to be lost to governments but replaced when consumers spend the savings on alternatives.

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CONGESTION COSTS PER VEHICLE-KILOMETRE

Congestion costs can be expected to increase as a result of the rebound effect of increased driving. For the recent U.S. light truck standards assessment, monetary values were available to DOT from the 1997 U.S. Federal Highway Cost Allocation Study, in which the marginal costs of additional light truck use, averaged over all traffic conditions, were estimated at 4.0 cents (U.S.) per vehicle-mile, in 2000 prices. Applying those values to the anticipated extra traffic due to the rebound, congestion costs reduced the final benefits assessed for the 2011-reformed standard by 9%, at a discount rate of 3%, and by 5%, at a discount rate of 7%.

Motorist delays due to congestion are expected to be somewhat less severe in Canada than the U.S., and the rebound rate for Canada's analysis is likely to be much lower than the 20% assumed in the U.S. study. The GoC's customary estimates of values of time savings/delays are also lower than those used by DOT (see item below on savings in refuelling time). Nevertheless, congestion costs from the rebound might still be significant in the analysis. Estimated costs will be obtained from TC's current Full Cost Investigation [14], as well as the recent study for the department on national congestion measurement [15].

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14 iTrans Consulting Inc., "Cost of Non-Recurrent Congestion in Canada", for Transport Canada, December 2006.

15 Delcan in association with ADEC and iTrans: "Costs of Congestion in Canada's Transportation Sector", for Transport Canada, March 2005.

SAFETY IMPACTS AND ACCIDENT COSTS PER VEHICLE-KILOMETRE

The U.S. design of attribute-based standards has taken pains to avoid any adverse effects on safety resulting from changes that might occur in the vehicle fleet. This is in keeping with the conclusion of the NAS study (in its majority finding) that changes in vehicle weight that accompanied the U.S. CAFE standards resulted in additional fatalities during vehicle collisions. That, in turn, was based primarily on an analysis by DOT staff of the relationships between vehicle mass and safety.

No comparable analysis has ever been done in Canada, to allow for an assessment of the changes in safety that might have accompanied the equivalent CAFC program. An analysis of Canadian collision experience will be undertaken as part of the development and evaluation of Canadian standards. Long-term trends in accidents/casualties will be investigated, together with information on developments in the vehicle fleet, population demographics, road network characteristics, safety programs and road user behaviour (notably, seat-belt use), as well as trends in CAFC. The study will provide an interpretation of the relative contributions of these developments and trends to aggregate accidents and casualties. The findings will be used to assess whether the proposed fuel consumption standards options are likely to have any effects on safety.

Whatever those findings are, some additional accidents and casualties can be expected to result from the rebound effect, compared to baseline risks. This was recognized in the evaluation of the U.S. light truck standards, in which DOT assumed additional traffic would be involved in crashes at average U.S. rates per distance travelled. Values for the additional costs were estimated as marginal external costs – i.e. those costs not borne directly by users themselves, and therefore not internalized. From the Highway Cost Allocation Study, the relevant costs were estimated to average 2.15 cents per mile and to reduce total benefits from the light truck standard in 2011 by 3% or 5%, using discount rates of 7% and 3% respectively.

For the assessment of options for Canadian standards, values for accident costs recommended for the GoC's cost-benefit analyses will be used. Those values, based on assessments of the same worldwide research, have been somewhat lower than those used by DOT. Canadian average casualty rates are also lower than those in the U.S., as is expected to be confirmed by the study of Canadian trends. The estimated costs of additional accidents from the rebound effects in Canada will consequently be proportionately lower than in the U.S. light truck assessment.

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GHG EMISSIONS COSTS PER TONNE

Monetary values of the social costs associated with GHG emissions remain the subject of a heated debate, worldwide. Experts vary considerably in their estimates of the amounts of damage to be expected from climate change. There are very few estimates of its likely financial costs. Values used in economic analyses have often been based on costs of emission reduction, rather than costs of damage itself. Some market values for emission reduction now exist in the transaction prices for emissions credits under the Clean Development Mechanism, or the European Trading System, but their relationship to damage costs is tenuous, at best.

In the U.S. light truck analysis, no value was assigned for reductions in GHG emissions, separately from the value of the savings in fuel costs. The analysis recognized that the value of such reductions to society should be included, but argued that research into the appropriate values remained inconclusive. The analysis received criticism for this omission.

For the Canadian analysis, the evidence will be reviewed and a value, or more probably a range of values, will be used to represent the findings.

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CRITERIA AIR CONTAMINANT (CAC) EMISSIONS COSTS PER TONNE

The primary effects on CAC emissions (specifically volatile organic compounds, nitrous oxide, particulates and sulfur oxide) expected from the introduction of fuel consumption regulations are a combination of those arising from reductions in fuel use, reductions in upstream production of fuels, and increases in driving due to the rebound. Estimation requires details of the relationships between CACs and fuels. It also requires assumptions about how fuel use will change with the standards, due to the effects of the fuel-saving technology, changes in vehicle use, and the rebound effect.

In the U.S. assessment, the net effect was estimated to be reductions in emissions of all four CACs. Monetary values were assigned based on recommended values from U.S. OMB [16], as follows (in 2001 prices):

Using these values, DOT estimated that the CAC reductions added 0.9%-1.3% to total benefits of the 2011 standards (the lower proportion being at the higher discount rate).

For the Canadian analysis, it can be expected that lower rebound will reduce that component of additional CAC emissions compared to the U.S. analysis. Money values will be selected from Canadian research and guidance, notably including Environment Canada's evaluations of initiatives resulting in CAC emission reductions, and TC's Full Cost Investigation.

Criteria Air Contaminants	Monetary values
Hydrocarbon (i.e. VOC)	$1,650 per tonne
Nitrogen oxides	$1,450 per tonne
Particulate matter	$55,000 per tonne
Sulphur dioxide	$8,050 per tonne

16 U.S. OMB: "Informing Regulatory Decisions: 2004 Draft Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities," December 2004, p. 34.

Noise costs per vehicle-kilometre

The rebound effect will also produce some increase in noise costs from road vehicles. Monetary values used in the U.S. analysis were again from the Highway Cost Allocation Study, based on research into the relationships of property values to transport noise. For light trucks, the estimates were 0.6 cents per vehicle-mile, and when applied to the rebound increase in travel, they reduced total benefits from the 2011 standard by just 0.1%.

Estimates in Canada are likely to be of a similarly minor significance to the final cost-benefit results, but will be included for completeness, using results of Canadian research.

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CONSUMER BENEFITS FROM ADDITIONAL DRIVING

The rebound effect is also expected to produce consumer benefits. Vehicle users' personal valuations of the additional travel are identified formally as their "consumers' surplus." The conventional approximation of such benefits in transport economics is that, among the extra users, the average value of the extra distance travelled is equal to half the cost reduction that stimulated it. This assumes that the value of the marginal increments vary in value between being fractionally below the original cost to being fractionally above the final cost, with an average therefore between the two.

That assumption was made in the U.S. analysis, adding approximately 1% to total benefits from the standard in 2011. The same approximation is intended to be used for the assessment of Canadian standards. It can be expected again that it will be of less significance than in the U.S. assessment, if a lower rebound is assumed.

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SAVINGS IN REFUELLING TIME

Improved fuel consumption might allow savings in the frequency of re-fuelling (if fuel tanks retain the same capacity, and drivers refuel at the same level of tank depletion).

In the U.S. light truck assessment, from rough assumptions about the frequency and nature of refuelling, the National Highway Traffic Safety Administration estimated that the average truck would save two and a half minutes of refuelling time per year. Valued at DOT's recommended value of road travel time, of $21.90/hour (in 2003 prices), the savings would amount to 5% of the total benefits estimated from the standard in 2011.

These estimates are very speculative, relying on rough assumptions about the frequency and extent of refuelling. However, the outcome is potentially significant enough that estimates will be made in the Canadian assessment. It is likely to be proportionately lower than in the U.S. analysis, particularly because TC's recommended average value for road travel time is lower, at $12.50/hour in 2006 prices.

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EXTERNAL COSTS OF PETROLEUM USE

According to the U.S. light truck analysis, the potential benefits resulting from standards include reductions in external costs from petroleum use. These had three elements:

1. Higher costs for oil imports resulting from the combined effects of U.S. import demand and OPEC market power;

2. Risk of reductions in U.S. economic output caused by sudden reductions in foreign oil supply; and

3. Costs for maintaining U.S. military presence to secure imported oil supplies.

In combination, these social costs were estimated in the U.S. Final Rule at $0.088 per (U.S.) gallon. Reductions in those costs added 2-3% to total benefits estimated in the U.S. analysis for model year 2011.

Given Canada's very different participation in world oil markets, as a major net exporter, it is not intended that such costs will be included in the analysis of Canadian standards; however, stakeholder comments are welcomed on this issue.

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ASSESSMENT OF THE EFFECTS OF NEW STANDARDS ON THE MOTOR VEHICLE INDUSTRY AND MAJOR COMPANIES

The analysis of potential technologies and costs will simulate the technology applications to each of the vehicle nameplates in the Canadian market, and calculate the expected increases in manufacturer's costs and retail prices. That will allow totals to be calculated across all nameplates for each manufacturer, which, in combination with forecasts of their sales (from the manufacturer's product plans, or the GoCs inferences of those plans) will allow estimation of the total costs to be met by the manufacturer, and of total increases in retail prices in each of the model years concerned, if sales were unaffected.

It can be expected, however, that sales will be affected as purchasers respond to price changes. Reductions in sales will be estimated based on assumptions of the relationship of changes in sales to changes in price (the price elasticity of demand), for each manufacturer. The basic assumption will be that sales will fall in the same proportion as vehicle prices rise (i.e. that the overall price elasticity of demand is -1). This is a common assumption in analyses of North American vehicle markets, and was confirmed in a recent review of research on elasticities and practice for TC[17]. This simple assumption will allow estimates of the sales reduction to be expected by each manufacturer.

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17 Lawson, J: "Investigation of Some Aspects of the Response of Consumers to Economic Instruments to Reduce Motor Vehicle Fuel Consumption," *op cit.*

Assessment of the Effects of the Standards on Consumers

As well as the cost-benefit analysis using social values, an assessment will be undertaken of the financial effects from the point of view of consumers. This will include the vehicle retail price increases they face, and the financial saving (including tax) they gain from the reduced fuel use. The rebound effect will be identified, including the extent to which it moderates the fuel savings.

The effects of the vehicle price increases and fuel savings will be examined by income class, to identify whether there are major differences among the classes. The Consumer Expenditure Survey will allow estimates of the spending on new vehicle purchases and fuel by household income class (income quintile, for example). It is not expected to be possible to predict the responses to vehicle prices and fuel savings by income class, but a simple assumption that the distribution by income class would remain the same will allow both the increased spending on new vehicles and the savings in fuel spending to be distributed by income class.

It can also be expected that the increased price of new vehicles will translate into increases in prices of used vehicles. Even in the first year the standards are applied, the increase in new vehicle prices is likely to allow the market prices of used vehicles to rise slightly. Then, in subsequent years, as the vehicles to which the standards applied are resold, their resale prices are likely to reflect some of their initial price increase. It seems unlikely that a quantitative analysis of these effects and their implications for consumers will be possible, but information will be sought, and a qualitative assessment at least attempted.

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Macroeconomic Analysis

The broader macroeconomic effects in Canada of the options will be examined. These will include primarily the effects on output and employment resulting from the actions taken by manufacturers and consumers to meet the standards. To do this, the GoC will rely on the national economic activity and energy use model Energy 2020 operated by Environment Canada, combined with Informetrica's TIM.

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