A Comparison of Five Green Trucking Programs across Canada

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Abstract

The trucking industry is a leading consumer of fuel and producer of greenhouse gas (GHG) emissions, inspiring federal and provincial governments to enact legislation and promote new green technologies. This paper evaluates and compares five provincial "green trucking" programs; from Alberta, British Columbia, Manitoba, Nova Scotia and Ontario. These programs were funded by the provincial governments and administered by various industry groups and non-profit agencies. Green trucking programs emanated from the Canadian Trucking Alliance's enviroTruck program, focusing on GHG emissions, fuel consumption and working conditions in heavy-duty trucking across Canada. Each program was launched independently and had unique scope and mandate. This comparison looks at the following factors: stakeholders (e.g. funders, administrators and beneficiaries); number of tractors and trailers submitted for consideration by the trucking industry; number of approved tractors and trailers by the programs; investment in green trucking technologies; and fuel conservation and emission reduction estimates. The paper presents key results from each program. It also offers public policy recommendations to facilitate improved trucking practices, in view of current anti-idling and clean air legislation. Finally, there are recommendations for trucking firms and private fleets regarding sustainable transportation best practices.

The Trucking Industry

Medium and heavy-duty trucks play an important role in the North American economy. Trucking generates employment; influences land use and real estate prices; and impacts commercial activities. According to the Canadian Trucking Alliance (2012), trucking is a $65 billion industry. It employs more than 260,000 drivers and nearly 400,000 Canadians overall. Concerns resulting from operation of the trucking industry include a deterioration of air quality and an unquenchable thirst for oil.

The Canadian trucking industry is made up of many small firms and a few large carriers. There are an estimated 23,402 "micro" trucking firms, with 1-4 employees; and only 19 "large" motor carriers, with 500 or more employees. In between these extremes are 7,773 small and medium carriers (Statistics Canada 2011).

Aging rolling stock, split ownership between tractors and trailers, and lack of information all impact the acquisition and installation of fuel efficient and emission reduction technologies. Negative externalities resulting from truck freight movement have caught policy-makers' attention. These factors pose serious challenges to safety, air quality and well-being of our communities. The challenge is to become more efficient and competitive by improving operating efficiencies and increasing energy conservation.

The industry was seriously affected by the recent recession. Volatile rates, rising operating costs, fleet reductions and diminishing loads hampered the industry's efforts to improve performance. Fuel costs have been among the top five critical issues for several years (ATRI 2005-2009). The cost of fuel also affects prices carriers pay for tires and lubricants. However, as the economy improved and fuel prices stabilized, priorities quickly changed to dealing with the economy; compliance, safety and accountability; and government regulations (ATRI 2009). Government regulations were the third most critical issue according to the 2010 survey.

Promoting Fuel Economy and GHG Emission Reductions

Initiatives to promote fuel economy, improve fleet and vehicle efficiencies, and reduce GHG emissions were anticipated by the industry as "unfunded" government mandates. These initiatives include advancements in vehicle technology, promotion of innovative freight practices and the use of on-board technologies and driver education. Currently, enacted regulations for Class 7 and 8 tractors and combinations in North America consist of vehicle-related emissions and fuel consumption standards. Though critical for compliance; reduced sulphur content in fuel, emission controls, improved vehicle aerodynamics, and on-board accessories result in higher rates – and increased costs for consumers. Implementation of these practices was initially seen as a burden by some industry stakeholders.

Despite the tremendous volumes of fuel consumed and emissions produced by trucking, there has been very little research published about green trucking programs in North America. In a recent article on the future of trucking, Larson, Elias and Viafara (2013) identify categories of sustainable trucking initiatives and obstacles to their implementation. The three primary green initiative categories are: practices (e.g. driver training), technologies (e.g. engine upgrades) and public policies. The main obstacles to implementation for truckers are cost of technology and availability of information to make informed decisions.

Historically, several policy factors have influenced adoption of truck fuel efficiency standards and GHG emission reduction technologies. These factors include: (1) federal regulations and standards (e.g. Energy Independence and Security Act, 2007; EPA and California Air Board Clean Air Acts), provincial and state climate change and action plans and municipal idling-reduction ordinances; (2) fuel economy standards for medium and heavy-duty trucks; and (3) the need to improve vehicle efficiencies due to trucking industry economics. The final objective of these approaches is to reduce dependency on sources of foreign oil, save consumers money at the pump, and create incentives to foster and/or accelerate the production and introduction of advanced technologies for the benefit of the transportation sector and the community at large.

Fuel Economy and GHG Emission Reduction Programs in Canada

The Transport Canada Freight Sustainability Demonstration Program (airwaterland 2004) and NRCan Fleet Smart/EPA Smart Way Partnership Program (SCL 2013) are programs sponsored by the Federal Government. They promote the acquisition and installation of fuel saving and GHG emission reduction technologies for tractors and trailers. These programs include behavioural components – e.g. speed reduction, on-board equipment and route optimization techniques – as sustainable transportation practices. Other components are driver training, performance incentives and rewards, electronic monitoring and satellite tracking.

The provincial governments of British Columbia, Alberta, Manitoba, Ontario and Nova Scotia have also sponsored a series of fuel efficiency and GHG emission reduction initiatives. These programs were designed to facilitate acquisition and installation of technologies to reduce GHG emissions, engine idling and fuel consumption. These initiatives also help reduce operating costs in trucking; improve fuel efficiency; and meet international climate change agreements and obligations to enact or comply with bilateral vehicle standards legislations.

A Sustainable Trucking Review

This section presents a review of “green trucking” programs promoted by the Provinces of British Columbia, Alberta, Manitoba, Ontario and Nova Scotia. The review focuses on stake-holders (e.g. funders, administrators, beneficiaries); number of tractors and trailers submitted by industry applicants and approved by the programs; level of investment in green trucking technologies; additional practices to improve fuel efficiency; and fuel economy and emission reduction estimates.

British Columbia: The Green Fleets (Enviro-truck) Program

The Fraser Basin Council (FBC) is a collaborative of multiple levels of governments and not-for-profit (NFP) organizations, established in 1997. It administers a series of programs; focused on climate change, air and water quality, watershed management, and hybrid and electric vehicles. The Green Fleets (Enviro-truck) program was a three-year initiative done in cooperation with the BC Trucking Association. Implemented from 2007-2009, the program received $3,000,000 in funding from the BC Ministry of Environment. It offered rebates to cover up to 50 percent of the cost of enviro-truck technologies. In addition, the program included alternative fuels, driver education, route planning and promotion of other sustainable trucking practices.

A total of 136 fleets participated in the program. They represented long-haul trucking, utilities, urban delivery, couriers, government and port terminal fleets. The program was aimed at fleets with newer engines featuring stringent reductions of particulate matter. Trucks were expected to have installed speed limiters to reduce fuel consumption. Further, the Green Fleets program established a fleet managers' network. The objectives were to share experiences and discuss green technologies and practices. Participants shared insights on fuel data collection, biofuels usage, fuel efficient driving practices, and urban-cycle electric and hybrid vehicles. Concurrent initiatives included the Bio-diesel, Idle Free and Supertrucks programs. Two other programs are *The E3 Review*, which strives to identify opportunities for improvement while assessing green fleet performance; and *E3 Fleet Rating Service*, which provides participating fleets with auditing services. Table 1 is adapted from the program's activity summary.

Unfortunately, "funding for this (Green Fleets) program was cut abruptly, which meant that some of the communications products were not completed in a manner that is suitable for public distribution." Targets shown in Table 1 above were set by the Government of British Columbia. Participant equipment in the program included 90 tractors and 54 trailers. Incentive amounts ranged from $10,000 per tractor trailer to a maximum of $50,000 per fleet. The total financial incentive provided was $308,248. Trailers accepted in the program were 2005 or newer, either vans or reefers incorporating add-on emission reduction technology (Fraser Basin Council 2013).

To participate in the program, truckers had to demonstrate the potential emission reductions resulting from selected technologies, along with baseline information leading to reductions in fuel consumption of 15 percent or more. The correspondence also indicates that "in some cases, fleets were using funding programs (such as the Transport Canada program) to leverage our funding. However, the numbers (in Table 1) reflect only the units to which we provided direct financial incentives." Stories about successes and company experiences with the Green Fleets program can be found at: http://www.e3fleet.com/fleet_experiences.html. An element of success was the realization by stakeholders that fuel efficiency and GHG emission reduction concerns affect all type of fleets.

Alberta: Trucks of Tomorrow

Climate Change Central (C3) was the agency responsible for implementing the 18-month Trucks of Tomorrow program. C3 is an Alberta-based NFP that promotes energy-saving strategies and programs. Government, municipalities and corporations have partnered with C3 to design and implement energy efficiency and GHG emission reduction initiatives. Launched in 2009, and finalized in December 2011, Trucks of Tomorrow offered $2,000,000 for incentive rebates and educational initiatives. Initially, there was a per company rebate cap of $30,000. This amount was later increased to $60,000. Rebates were set at 20 percent of the average purchase price of the technology. The budget for rebates was $1,450,000; with another $550,000 set aside for program administration, advertising, materials, case analysis and workshops.

The main objective of the program was to "help Alberta transport companies drive down $C0_2$ emissions through improved fuel efficiency" (C3 2012). The program was designed to support Alberta's Climate Plan in achieving substantial GHG emission reductions. The two program components were rebates (management and administration) and education (case studies, fleet analyses and workshops). The program was advanced in cooperation with the Alberta Motor Transportation Association (AMTA). The FBC performed fleet fuel consumption analysis. Case studies provided real world information on the benefits of the green technologies. Participant survey results indicate that the program encouraged commercial vehicle operators to adopt fuel-efficient and aerodynamic technologies. The program received a total of 427 applications. Tables 2 and 3 summarize the spending on and volumes of various technologies implemented by participant companies, respectively.

While the program was targeted at commercial fleets, some urban fleets (class 5 vehicles) and government agencies also applied for the "hybrid" rebates. According to the budget, the aim was to distribute about 2,500 rebates. Ultimately, the program distributed 3,063 rebates to 427 approved applicants. Trucks of Tomorrow contained a number of unique features, such as a "booking" system to set aside funds for every approved applicant. The Final Report indicates that some participants thought the number of technologies available were too limited. Tires were not included. Some prospective participants felt excluded, and they concurred that the inclusion of tires would have allowed more companies to benefit from the program.

The educational component offered workshops and emphasized the importance of case studies as learning and sharing tools. Valuable information about the technologies, their usage, pay-back periods and fuel efficiencies was drawn from the case studies. The case studies also show-cased additional environmental initiatives implemented by Alberta trucking firms, served as testimonials for interested truckers, and provided "how to" information for increasing fuel efficiency. They also provided recognition to leading sustainable companies in the province.

Fleet analysis covered lifecycle emissions, fuel efficiency and consumption, and vehicle utilization, as well as fleet operational and capital asset profiles. Vehicle utilization is a critical aspect of fuel management. The program provided information on under-utilized fleets,

average age of fleets, excessive emissions, downtime and costs of repairs. "Best-in-class" comparisons contributed to the analysis, potentially leading to vehicle replacement. Workshops on the benefits of fuel efficient practices, fuel management and fleet analysis were delivered in various locations. An outreach program was developed to promote the various activities, communicate with participants and build community partnerships. Telephone support facilitated data collection, error checking and analysis.

A driving premise was "targeted use of financial incentives," compelling program managers to evaluate stakeholders and the participants. Similarly, financial analyses were performed to establish whether the rebates were cost-effective means to reduce GHG emissions. Free-ridership and spillover analysis were done using information gathered at the beginning of the program. *Free-ridership* is "energy savings that would have been achieved even if (the truck owner) had not participated in the program." *Spillover* "captures program savings that go beyond the measures installed through the program." It is an awareness of the benefits resulting from participating in the program (C3 2012).

The final element in program evaluation was economic analysis. This was pegged to ongoing improvement of public services in Alberta. It seeks to assure public funds are spent on activities that bring the greatest benefits to taxpayers. Borrowing from the public utilities sector, a series of screens were used to gain information about the initiatives from the perspectives of stakeholders, participants, administrators, ratepayers and administrators. Program administrators assessed societal costs, based on the theoretical foundation for public decision-making that asserts: "a public policy is a good policy, so long as gainers can in principle compensate losers and still have some net gains left over. Every public policy has winners and losers, but what matters is that, in aggregate, society collectively is better off" (C3 2012). Program managers received a positive response from participants. According to the final report, "about $6.7 million of private investment resulted directly from program-related activities undertaken by participants." Taking account of *free-riders*, approximately $3.3 million of private investment is attributable to the program. Thus, every dollar invested by the Government in the program induced about $1.60 dollars of private investment" (C3 2012).

Manitoba: The GrEEEn Trucking Program

The Province of Manitoba launched the GrEEEn Trucking Program in 2009. The program offered financial incentives to owner/operators and other truckers to adopt "GrEEEn" (Economically and Environmentally Efficient) technologies to reduce idling, fuel consumption and emissions. The program made the purchase and installation of green technologies more economically feasible. It also helped carriers lower emissions through improvements to vehicle standards, and reduce fuel consumption and other operating costs by improving vehicle and fleet efficiencies.

The program was directed at Manitoba-based companies, holders of valid Manitoba National Security Code Certificates and Manitoba Driver's Licenses. Another qualifying condition was that participant companies had not received funding from another "green fleet" (EPA/NRCan

Fleet Smart) program. Eligible tractors and trailers for Phases I, II and III were model year 2005 or newer. For Phase IV, eligible tractors and trailers were model year 2007 or newer.

Participants were expected to invest a minimum of $2,000 per unit purchasing and installing environmentally efficient technologies. Selected technologies for tractors included side fairings, low rolling resistant tires, tire pressure monitoring and inflation systems and Auxiliary Power Units (APUs). Technologies available for trailers included side skirts, gap fairings and trailer tails/base flaps. Offered incentives were based on a percentage of the estimated cost of the equipment installed, ranging from 15 to 25 percent. The maximum rebate was $2,500 per unit. Based on fleet size, long-haul companies were entitled to apply for a maximum of 20 units or combination of tractors/trailers for Phases I and II (2009). Companies were entitled to apply for a maximum of 15 units or combination of tractors/trailers for Phase III (2010) and Phase IV (2012). Table 4 provides a summary of the four phases of the program, including number of participants and total amounts disbursed in rebates. The figures do not include administration costs.

APUs help operators reduce the use of main diesel engines to maintain climate control during short or prolonged en-route stops, e.g. queuing for entry at ports, border-crossings, rail yards, warehouses and loading docks. Side skirts reduce fuel consumption and enhance engine performance by reducing friction from air currents under the vehicle. Low rolling resistance tires also improve fuel efficiency. Single wide-base tires are lighter than two standard tires, and have lower aerodynamic drag; contributing to increases in load capacity for weight-limited vehicles. All preferred technologies reduce GHG emissions and improve the quality of life in communities.

The fleet size criteria introduced a sense of “equity” among applicants, and motivated carriers to promote the program amongst their network of owner-operators. Applicants provided baseline information on fuel usage, distance travelled and other items for each qualifying unit to request payment of rebates. There are other factors that impact selection, acquisition, and installation of fuel efficient and emission reduction technologies. For instance, type of business ownership, revenues, hauling distance, regulations, age of vehicle, leasing conditions, routes, highway conditions and access to rest-stops, and compliance with various sustainability score-cards, all appear to influence the selection of technologies. As noted above, motivation for and barriers to installing these technologies varies. For instance, the Alberta Trucks of Tomorrow found lack of information to be a barrier to acquiring/installing green technologies (C3 2012).

Three important features of phases I-III of GrEEEn Trucking were: (1) economic development and price analysis; (2) use of the EPA emissions quantifier Model (DEQ); and (3) analysis of sustainable transportation practices. Unfortunately, these features, along with a proposed survey to “aid in the final assessment process and to gather participant’s perceptions of the program” (UMTI 2010a) were not pursued in Phase IV.

Part of the program's assessment entailed an analysis of investments made by participants compared to amounts received in rebates. The "Participant Investment" column in Table 4 indicates that applicants were committed to retrofitting their equipment. They were motivated to meet program objectives, reduce fuel expenses, meet jurisdictional requirements, and/or meet sustainability scorecard benchmarks. For instance, Wal-Mart assesses suppliers' impact across four areas: climate and energy, material efficiency, natural resources, and people and community (Brady 2010). The data show that truckers are aware of the advantages of more sustainable operations, despite economic turmoil and increased equipment costs.

The program required participants to acquire the selected technologies only from Manitoba-based companies. The estimated market value of equipment submitted to the program was nearly $3 million. As a result, the economic effect of the purchases of equipment, installations and repairs of selected technologies resulting from the program were significant (see Table 4).

As only a few providers in Manitoba sold the qualifying technologies, an assessment of pricing was undertaken. This was done to make prices visible, and because subsidies and rebates could potentially distort the market. Labour and equipment costs were separated. Results indicated no statistically significant difference in prices paid by participants to local suppliers. Apparently, participants fully enjoyed their rebates, as purchasing power of the rebate was not eroded by price increases. Although allocated rebates were a sound economic development instrument, further research is needed to fully understand the benefits.

In Phase III, GHG emission reductions resulting from installation of sponsored technologies were measured using the EPA Emissions Quantifier Model (DEQ). The model measures "retrofits" or the impact of those technologies on overall vehicle performance. This is particularly important when old vehicles are retrofitted to comply with existing regulations. Rather than providing information on emission reductions resulting from installation of a particular technology, the model considers a vehicle's model year and estimates emission reductions, cost effectiveness, and health benefits due to installation of technologies on a vehicle or fleet.

There are other practices for improving efficiency of the trucking industry, which do not require installation of any of the approved technologies. These practices are based on driver behavior, company policy, use of speed limiters and other practices to manage routing, loading and freight movement problems. The Phase III survey found significant differences in the use of on-board technologies, implementation of speed policies, and use of freight matching services (to reduce empty backhauls) between for-hire and owner-operators (UMTI 2011).

The survey was informed by Natural Resources Canada's 2009 *Efficiency Benchmarking in Canada's Trucking Industry Survey* and various key performance indicators developed by the UK Department of Transport. The survey tested for the presence of 11 fleet or vehicle sustainable transportation practices. A comprehensive trucking fuel economy and GHG emission reduction program should seriously consider the assessment of these practices, including the impact of driver behavior. Such behavioral changes are important elements in reducing GHG emissions

and combating climate change (Markowitz and Doppelt 2009). Driver behavior demands more attention particularly when tractors have been found operating without their factory-installed emission reduction technologies, such as Exhaust Gas Recirculation (EGR) or Selective Catalytic Reduction (SCR) devices (OTA 2013).

Finally, another exercise consisted in geographically locating the participants from Phases I-III, based on the assertion that trucks registered in rural areas tend to be nine years or older, serve domestic farm operations and travel short distances. A large number of for-hire and owner-operators were located in rural communities. These also submitted a large number of new units.

Ontario: Ontario Green Commercial Vehicle Program (OGCVP)

In November 2008, the government of Ontario introduced a four-year, $15 million program to assist operators of commercial vehicles to invest in fuel economy and GHG emission reduction technologies. Funding was divided in two types of grants: $11 million for purchasing alternative fuel vehicles and $2.9 million for purchasing anti-idling devices for heavy-duty trucks. The program was endorsed by the Ontario Trucking Association (OTA) as consistent with its Enviro-truck vision. Ontario-based companies were eligible to apply for grants to purchase anti-idling devices; auxiliary power units; cab heaters; and hybrid, all electric and/or dedicated alternative energy vehicles. Participating companies collected data resulting from the installation of green technologies.

The program was retroactive to August 2007. It was administered under the Ontario Green Commercial Vehicle Program (OGCVP). Participant vehicles could operate in urban, highway or rural environments. The program was open to vehicles Class 2 to 8. It was an integral aspect of GHG emission reduction strategies in the *Go Green Action Plan*.

As of September 2010, the program had issued 183 grants for acquisition of alternative fuel vehicles (hybrid, all electric or natural gas), at 33 percent of incremental cost to a maximum of $15,000 per eligible vehicle (ECO). The OGCVP also provided grants for 1,108 retrofits of anti-idling devices. It had awarded approximately $3.2 million in grants (of $13.9 million available).

A 2010 report indicated that “the program has not been as successful as anticipated.” While grant applications for alternative fuel vehicles were much lower than expected, grants for anti-idling devices were more successful. Stakeholders’ reluctance to embrace alternative fuels and technologies, along with poor trucking industry performance during the 2008-2009 recession, curtailed interest in the program. The report indicates the Environmental Commissioner’s Office “believes that the ministry should provide a report in 2011 that analyzes the program’s effectiveness, and make recommendations on whether and how the program should be expanded. If the program is continued or expanded, the ECO will monitor the results for possible inclusion in future reports.”

As noted above, initiatives to promote fuel economy, improve fleet and vehicle efficiency, and reduce GHG emissions were anticipated by truckers as an "unfunded" government mandate. Even before its inception, the enviro-truck program was considered by the trucking industry as an incentive program to help defray costs to acquire 2007 engines. Hence, the industry asked the Federal government to approve financial or tax incentives for the new, environmentally-friendly engines, and to harmonize the federal excise tax on diesel fuel with the federal goods and services tax (GST).

A program greeted with great expectations in 2008 had been scaled back or cancelled by December 2012. A media report indicated that "Ontario's environment watchdog had criticized the provincial government for not doing enough to combat climate change, warning the province will not meet its own environmental targets in 2020 and 2050." The cancellation of the Ontario Green Commercial Vehicle Program could have been a determining factor.

Nova Scotia: FleetWiser (Greening the Fleet Rebate Program)

This program was implemented by Clean Nova Scotia, a NFP organization working on climate change, water stream restoration, community energy conservation, sustainable transportation and waste reduction. A primary goal of Clean Nova Scotia is to reduce GHG emissions through efficient fleet management and sustainable transportation strategies. The Driver Wiser and Fleet Wiser programs were implemented to meet that goal. Current initiatives include fuel efficient driving and emission reduction, in-vehicle training, fuel and fleet management, and maintenance.

In the fall of 2011, the *Greening the Fleet* program provided rebates to optimize vehicles and equipment, and fostered adoption of idle-reduction and driver training initiatives (Gillis 2012). Program technologies included anti-idling and emission control devices, fleet management and route optimization tools, aerodynamic equipment, low rolling resistance tires, and tire pressure monitoring solutions. The total budget for the program was $40,000. Rebates covered up to 30 percent to a maximum of $2,500 + HST per vehicle. Participants acquired and installed various technologies to reduce fuel consumption, operating costs and GHG emissions.

The budget for "Greening the Fleet" appears low. However, various fleets representing school buses, urban delivery, service call, municipal fleets and flexible car-share fleets benefited from the program. Acquired devices included onboard tracking systems; route planning software; APUs; LED beacon lights; a Battery Brain mechanism, to reduce idling and battery drainage; and a governed reduced idling package (GRIP). The program was delayed for lack of funding. More recently, the Greening the Fleet program was successful in receiving funds from the Nova Scotia Moves Grant Program. This will make it possible for a car-share provider and stakeholders to work together toward equipping two wheelchair accessible vans.

In addition, the Government of Nova Scotia, through its Transportation Efficiency Incentive Programs, will be spending about $3,500,000 on:

(1) Equipping school buses with fuel-efficient technology such as heaters and timers, route optimization software, and emission control technology ($1.35 million)
(2) Enabling purchase of anti-idling devices, aerodynamic improvements, fuel-efficient tires, and other fuel-reducing technologies for heavy duty class 8 trucks ($1.0 million)
(3) Supporting purchase of heavy duty hybrid vehicles including bucket trucks and other fleet vehicles ($1.0 million)
(4) Public education and awareness promoting fuel-efficient personal vehicles ($150,000).

Observations

U.S. and Canadian federal, provincial and state governments have enacted legislation, set fuel efficiency and emission reduction standards, promoted the introduction of new technologies, and advanced regulations to improve opportunities to mitigate the environmental impact of freight transportation.

Advancements in vehicle fuels and engine technologies originate in the Environmental Protection Agency's (EPA) movement toward a "clean diesel" program since 2000. The agency set 2007 as the target year to reduce the level of sulfur in diesel fuel, and to reduce harmful pollutants from heavy-duty highway vehicles, by more than 90 percent (EPA 2009). Stringent rules were aimed at improving the performance of heavy-duty engines for highway tractors and buses. By law, 2007 model-year engines reduce emissions of particulate matter, a precursor of smog linked to respiratory disease, by 90 percent. In 2010, the EPA targeted the other major precursor of smog, NO_x, for reduction by 95 percent.

The EPA anticipated substantial reductions of NO_x emissions, along with reductions in acute cases of respiratory illnesses and asthma related attacks. The Agency put a value on some of the negative externalities associated with trucking. However, the era of smog-free trucks in Canada came at a premium. Bradley (2007) estimated that "new engines are much more expensive to purchase, in the order of 7% to 10%." The projections for heavy-duty tractors (in 1999 US dollars) were $3,230 extra "near-term" costs for the 2007 model, and $4,626 "long-term" costs for 2012 vehicles. Projections for heavy-heavy-duty tractors was $1,870 extra "near-term" costs for the 2007 model and $4,030 "long term" costs for 2012 vehicles (EPA 2000).

The Canadian Trucking Alliance (CTA) envisioned the Enviro-truck initiative; a quick response to the advent of Model Year 2007 engines for tractors and buses. Long-haul trucking was at the crossroads between prior fuel consumption and GHG emission reduction public policies. The industry was compelled to cut fuel costs and consider community concerns by reducing carbon emissions for society's betterment. The objective was to accelerate the introduction of clean trucks in the Canadian fleet, to get as many new trucks as possible on the road.

However, 2005 to 2009 were times of turmoil and equipment constraints for the trucking industry. The Enviro-truck program promised paybacks for the industry (fuel savings) and for government (less smog and GHG emissions). The industry was requesting: (1) a Government of Canada investment of about $56 million, compared to an industry investment of $320 million; and (2) a prompt launch, which was more important than the duration of the program (Bradley 2007). During this period, the Canadian Government financially assisted the trucking industry in its promotion of anti-idling and GHG emission reduction initiatives.

Comparative Review Analysis

Consistent with the Enviro-truck concept proposed by the CTA, five Canadian provinces (British Columbia, Alberta, Manitoba, Ontario and Nova Scotia) funded and implemented "green" trucking programs. The objective was to "accelerate the acquisition of the new, mandatory, smog-free trucks combined with proven technologies that will reduce fuel consumption and lead to lower GHG emissions" (CTA 2007). Targeted units were model year 2007 with speed limiters set at 105 km/hr. Because many of the qualifying units were in the market, a second objective was to "help a variety of fleets introduce green technologies, tools and practices" (CTA 2007). Participating technologies included anti-idling devices, aero-dynamics and tire packages for tractors and trailers. Some participating governments also sponsored hybrid refrigeration, engine control and tire inflation systems. Other selected technologies included boat tails and double trailer combinations.

Objectives

The Enviro-truck program targeted Class 8 tractors in Canada. The focus was on installation of fuel saving and emission reduction technologies. However, the objectives changed to fit local realities. The Ontario program promoted the purchase of Class 3-7 dedicated alternative fuel vehicles. Ontario also supported retrofits to Class 8 vehicles with anti-idling devices. Alberta accepted Class 5 to Class 8 vehicles; and Nova Scotia accepted courier, ambulances and other municipal vehicles. Manitoba and British Columbia focused on long haul Class 8 tractors.

The governments tied economic and social objectives to the programs. Economically, programs would improve the competitiveness of the Canadian long-haul trucking industry. Workshops, case studies and educational activities accounted for the social component. Related projects enhanced these activities, such as research projects advanced by the implementing agencies. Including administration costs, program funding ranged from $40,000 to $3,600,000.

Application process

Eligible companies were private-sector long haul vehicles and fleets registered in their own jurisdictions. The provinces, except Nova Scotia, excluded municipal fleets and passenger vehicles. Rebates to purchase eligible technologies ranged from 15 to 33 percent of their costs.

The various implementing agencies designed application forms and complementary forms to gather participant and vehicle information.

The range of data collected was as diverse as the activities advanced. Compulsory data included fuel consumption and vehicle miles (kilometres) traveled. Additional information included vehicle characteristics, type of engines and type of services, as well as the availability of long-haul sustainable transportation practices and driver education programs.

The application for some technologies (anti-idling) and the low acceptance of others (wide-base tires) appears to reveal the existence of some jurisdictional barriers preventing companies from applying. Routing issues, connectivity and mobility may also conspire against acceptance of wide-base tires. It is forbidden to drive vehicles with wide-base tires on certain provincial and state roads.

Except for fuel consumption and miles traveled, other indicators of vehicle and fleet efficiency were not uniformly gathered. Three programs conducted vehicle and fleet analysis. Alberta went further to incorporate analytical techniques widely used in the energy sector. Manitoba used the information collected to study geographic location of participants, perform a price variability analysis, and conduct a survey of long-haul sustainable transportation practices.

It appears data collected was sufficient to meet the programs' objectives. However, in some cases, the length, design, content and completion procedures of the forms to collect basic participant and vehicle information could be improved. As observed in one province, many applicants appeared to lack the literacy and numeracy skills needed to complete the paper-work. Indeed, equipment suppliers completed and submitted many of the applications.

Participants were required to sign terms and conditions to ascertain their eligibility in the programs. However, it is not clear whether program administrators tested terms and conditions documents for readability or discussed scope and content with their stakeholders. Thus, a review of terms and conditions to establish program eligibility demands consideration.

Analytical Tools, Calculators and Models

There are several air quality and emission analysis models currently in use in Canada, including those promoted by the EPA. Since 2005, Canada has established transportation partnership initiatives with the EPA to promote the deployment of innovative fuel saving and emission reduction technologies. An example of this partnership is EPA's SmartWay (technologies) and NRCan's Fleet Smart (driver education). A series of analytical and modeling tools are available to support the efforts promoted by the SmartWay Program to cut emissions from the freight sector (EPA 2005). There is an assortment of tools, calculators and models to calculate fuel economy, costs/benefits, and emission costs.

Each program collected information to assess fuel savings and estimate GHG emission reductions resulting from the installation of green trucking technologies. Although each analysis appeared sound, programs used an assortment of tools, calculators and models to estimate fuel efficiency and emission reductions. While programs identified the sources of emissions, it was not clear whether the final output could help corresponding jurisdictions track the components of GHG emissions. Largely, the analyses focused on the savings resulting from application of the technologies alone.

This approach impinges on policymaker's ability to consider behaviours, vehicle characteristics and operations as contributors to GHG emissions. Unfortunately, program reports offered little guidance on selection of prospective GHG emission reduction tools. Recommendations on using a certain calculator, air quality model, emission analysis or standard approach would be beneficial. This would facilitate comparing results and effectiveness across programs.

Concluding comments

Reputable environmental and transportation research agencies advanced the green trucking programs described above. The enviro-truck program benefitted greatly from the diversity of approaches advanced by the implementing agencies. These agencies went beyond estimation of fuel savings and emission reductions. Novel approaches included vehicle and fleet analysis, lifecycle cost of emission, and study of idling costs. Funder considerations lead to the analysis of the soundness of financial incentives, their cost-effectiveness and analyses to heighten the impact of the proposed practices at the community level.

The economic impact of the program was widely studied. Considering the amount disbursed in rebates, participants' investments in technology and actual cost of the equipment presented, the programs were an economic success. It became clear that fuel efficiency and GHG emission reduction strategies are much stronger when supported by educational and driver behaviour initiatives. Driver education programs played an equal role to installation of the technologies. The economic role of trucking in Canada is tremendous. Future work in this area should focus on job creation, purchasing power, asset net worth, fleet age, inventory, and other important indicators; in addition to analysis of emissions.

Although the focus was on installation of fuel saving and emission reduction technologies; the need to address driver behaviour became an important social component of the programs. For instance, the sustainability practices survey in Manitoba revealed that rewarding performance seems to motivate drivers, enhance retention, and improve safety. Further, acceptance of on-board speed reduction, idle-reduction, engine downloads and freight matching technologies was more prominent among for-hire firms compared to owner-operators (UMTI 2011). Those technologies and practices are proven to contribute to fuel savings, emission reduction and fleet optimization.

Further work

As federal, state, provincial and municipal governments enact legislation and establish programs to enhance fuel economy and reduce GHG emissions, further research is needed to assess the broader impacts of green trucking. For instance, it is important to realize that the purchase of an anti-idling device accounts for more than comfort for the driver. These devices are smaller in nature, more affordable, less weight on the tractor, and less burdensome on the unit than other devices.

It appears that trucking is approaching a phase of "rationalization" of equipment usage in relation to available enviro-trucking technologies. Bottom-line impact is important in the acquisition and installation of devices. Are companies performing cost-benefit analyses and vehicle and fleet analyses before acquiring sustainable technologies? Are there differences between the motivations of an owner-operator, a for-hire firm or a private fleet?

Are there relationships between routes, loads, services, available equipment and selected technologies? The answer could provide valuable program design insights. As shared by a couple of participants, some trucking companies are becoming more "route" conscious. As a result, fuel purchases, loads and operations could be framed by the requirements of serving the route. Other issues, such as empty back hauls, use of load matching boards and the need to keep operating costs under control, have the potential to cause the industry to seriously consider long distance "routing" as a sustainable and cost cutting alternative.

The observations outlined here deserve further consideration. To our knowledge, this is the first time a comparative review of green trucking programs has been undertaken. This is work in progress. Both government and industry stakeholders will benefit from its findings and recommendations. New enviro-truck-like programs are around the corner. As the industry embarks on a campaign to reduce financial and legislative barriers to the adoption of energy efficient devices, lessons learned from previous programs will be beneficial. A coordinated approach will facilitate successful implementation of fuel efficiency and emission reduction programs in the future.

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Table 1. Green Fleet BC Program Activity Summary, 2007-2009

Program Delivery	Target	Actual
Number of new vehicle types on the Hybrid Experience website	12	13
Number of medium duty hybrid vehicles organized	10	15
Number of Green Fleet network meetings	5	5
Number of outreach activities (e.g. workshops, meetings)	140	231
Number of media hits	31	69
Participation		
Number of new fleets, all programs (Biofleet, E3, Idle Free, etc.)	140	135
Number of fleets participating in "EnviroTruck" long-haul trucking demo.	8	11
Number of new fleets demonstrating the use of alternative fuels	50	35
Number of fleets making new commitments under E3 Fleet program	25	34
Number of new fleets participating in Medium Duty Hybrid demo	8	8
Number of new fleets participating in Idle Free BC	50	64
Average unique monthly visitors to Hybrid Experience website	17,000	15,775
Average unique monthly visitors to the Green Fleets BC website	1,500	2,375
Financial Leverage and Partnerships		
Financial leverage (incentives + cash)	$1,500,000	$2,410,080
Number of strategic partnerships	15	14
Projected Emissions Reduction[1]		
Program NOx (tonnes/yr)	125.0	124.7
Program PM (tonnes/yr)	1.5	2.5
Program GHGs (tonnes/yr)	8,500.0	19,192.3

Adapted from: Fraser Basin Council (2012) Evaluation Framework Green Fleet BC

1. Annual emissions reduction projected for the following fiscal year.

Table 2. Alberta Trucks of Tomorrow: Incentive Spending ($)

Spending	Auxiliary Power Units	Cab Heater/ Coolers	Fairings	Skirts	Hybrid	Total
Initial Funds						1,450,000
Transferred in						119,400
2010-11	82,500	200,400	0	135,500	0	418,400
2011-12	199,500	486,000	40,300	391,500	28,000	1,145,300
Total Spent	282,000	686,400	40,300	527,000	28,000	1,563,700
Remaining						5,700

Adapted from: Table 4.1, Trucks of Tomorrow Final Report (2012)

Table 3. Alberta Trucks of Tomorrow: Equipment (units)

Equipment	Auxiliary Power Units	Cab Heater/ Coolers	Fairings	Skirts	Hybrid	Total
2010-11	55	501	0	271	0	827
2011-12	133	1215	101	783	4	2236
Total	188	1716	101	1054	4	3063

Adapted from: Table 5.1, Trucks of Tomorrow Final Report (2012)

Table 4. Manitoba GrEEEn Trucking Program Summary 2009-2012

Phase	Firms	Tractors	Trailers	Program Investment	Participant Investment	Total Rebates
I	14	28	17	$360,000	$3,551,000	$83,226
II	32	79	13	$788,000	$9,297,004	$156,694
III	36	109	38	$954,822	$13,698,076	$227,612
IV	28	106	24	$818,708	$13,103,758	$174,292
Total	110	322	92	$2,921,530	$39,649,838	$641,824

Source: GrEEEn Trucking Reports Phase I-II-III/ First Draft Phase IV