Sustainable freight transportation in North America

Mapping the road to a sustainable future

Background information developed as part of the Commission for Environmental Cooperation (CEC) Secretariat's latest independent study under Article 13 of the North American Agreement on Environmental Cooperation.

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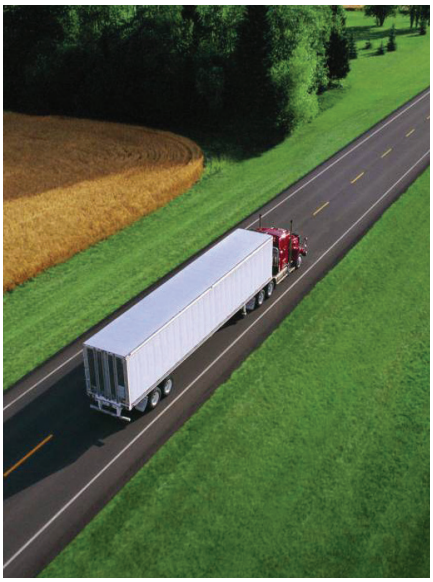

The CEC Secretariat has commissioned the Texas Transportation Institute (TTI) to review the current status of freight transportation in North America from a sustainability perspective. This document is a summary of the facts and figures as well as challenges identified in the TTI review. The information contained herein is the responsibility of the authors and does not necessarily reflect the views of the CEC, or the governments of Canada, Mexico or the United States of America.

Facts and Figures on North American Freight Transportation

Introduction

Transportation is one of the major contributors to the release of greenhouse gases (GHGs) in the atmosphere, producing more than one-quarter of the total GHGs released in North America. However, differences in emissions estimation methods among Canada, Mexico and the United States make it difficult to establish what proportion of GHGs that can be attributed to the movement of freight. This in turn has hindered progress towards mitigation of GHGs from the various modes freight transportation. The intent of this document is to provide some basic facts and figures on GHG emissions and abatement efforts pertaining to the freight transportation system in North America.

The North American Freight Transportation System

Commodity movements between the three North American countries are concentrated in transport between Canada and the United States and between Mexico and the United States, as the amount of goods shipped between Mexico and Canada is relatively small. Canada is the number one US trading partner and Mexico is the third-largest US trading partner. Truck transport is the dominant mode for the movement of goods between the three countries (Figure 1).

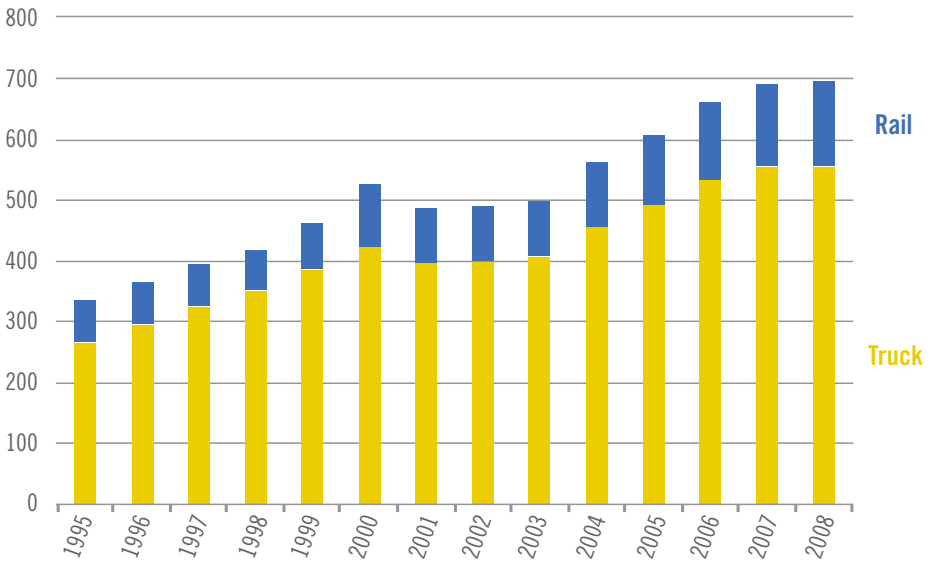

Figure 1: US Land Trade with Canada and Mexico, by Mode (billions of US$)

Source: Developed by TTI with information from the US Department of Transportation, Research and Innovative Technology Administration, Transborder Freight Data.

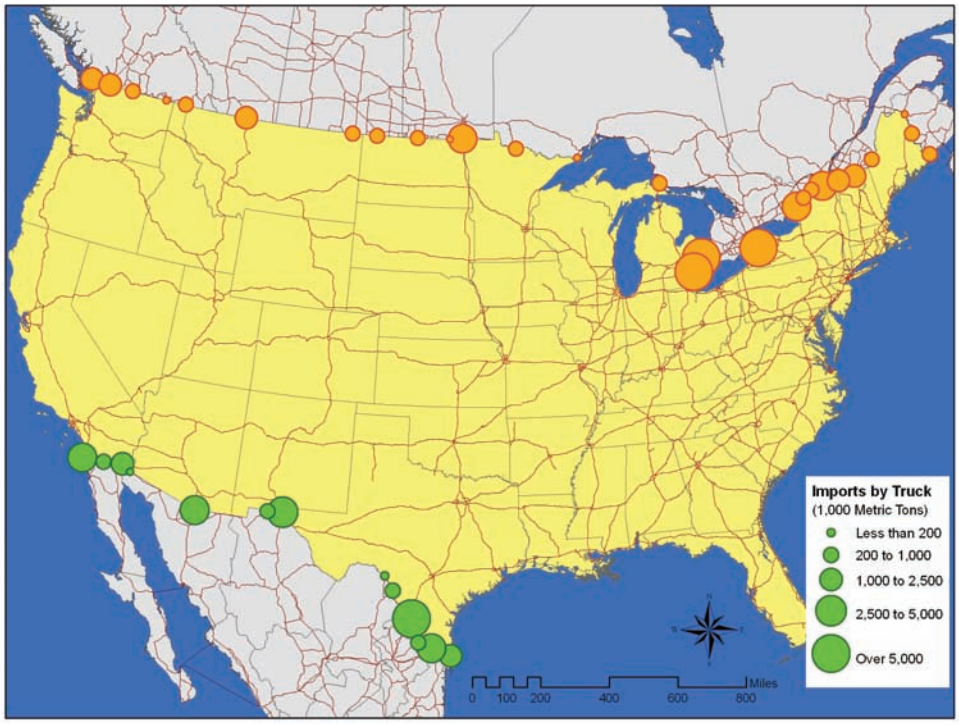

Figure 2. 2008 US-Canada and US-Mexico Major Ports of Entry

Source: Developed by TTI with information from the U.S. Department of Transportation, Research and Innovative Technology Administration, TransBorder Freight Data.

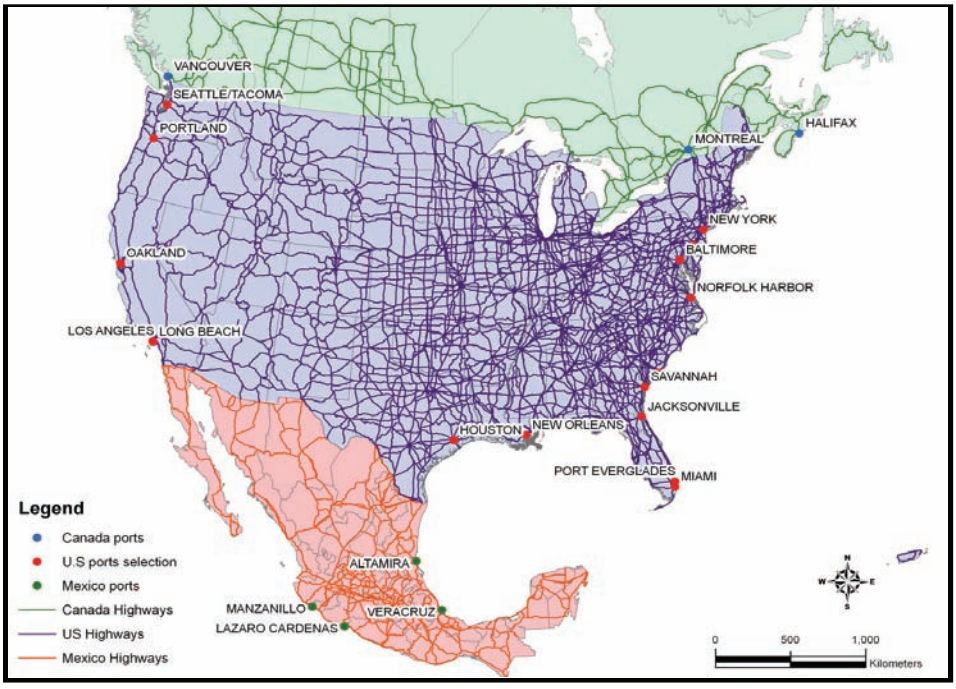

Figure 3. North American Class I Highway Network and Major Maritime Container Ports

Source: Developed by TTI with information from the American Association of Port Authorities.

In 2008, approximately one-half of the total truck and rail traffic by value in North America was handled by three land ports of entry: Detroit/Windsor, Nuevo Laredo/Laredo, and Buffalo/Niagara Falls. At the US-Canadian border, more than 75% of the surface trade was handled by only five land ports of entry, while at the US-Mexican border, only four ports of entry handled about the same amount of the total land trade (Figure 2).

Freight transportation throughout the continent is interconnected, covering all three countries, with congestion issues at binational land border crossings and maritime ports. International trade with regions outside North America is primarily handled by maritime ports. In North America, the top 25 ports that handle containerized merchandise include three Canadian ports, four Mexican and 18 US ports (Figure 3). The volume of North American container port traffic doubled between 1995 and 2008, experiencing close to a 6% average annual growth rate.

The Correlation between Freight Transportation and GHGs

Domestic freight transportation (within each country) is mainly handled by the truck and rail modes. The United States has the largest domestic freight transportation system, with more than 2.858 trillion ton-miles, compared with approximately 276 million ton-miles in Canada and 150 in Mexico.

The primary fuel of freight truck and rail is diesel—a petroleum product, i.e., a fossil fuel. GHGs are byproducts of combustion of fossil fuels, such as oil and coal, and there is a direct relationship between fossil fuel use and GHG production[1]—the more fuel burned, the more GHGs produced. The freight transportation sector in the United States is the most extensive among the three North American countries—hence, it generates the largest proportion of GHGs (Table 1).

For 2010, OECD has projected that North America will produce 7,343 million metric tons of CO_2 emissions.[2] The 2,058.6 million Mt CO_2eq produced by the North American transportation sector overall, as totaled from various years and estimation methods in

1. Cited by the US DOT's Climate Change Clearinghouse at http://climate.dot.gov/ghg-inventories-forcasts/national/us-inventory-structure.html#fore. Note that one million metric tons is equivalent to one teragram.
2. GHGs emitted by the rail and truck transportation modes consist of 96% Carbon Dioxide (CO_2) by volume. The remaining GHGs are methane (CH_4), nitrous oxide (N_2O), and fluorinated hydrocarbons (HFCs).

Table 1. Transportation-related GHG Emissions in North America

	Greenhouse Gas Emissions (Million Mt CO_2eq*)***		
Mobile Source	**United States (2007)**	**Canada (2006)**	**Mexico (2002)**
On-road Subtotal, including:**	1,554.7	132.4	101.9
Light-duty cars and trucks	1,145.8	78.2	n.d.†
Heavy-duty gasoline trucks	35.6	12.0	n.d.
Heavy-duty diesel trucks	371.3	49.6	n.d.
Railways	46.0	6.0	1.6
Domestic Marine	8.1	5.8	2.3
Domestic Aviation	185.2	8.4	6.3
Total Transportation	**1,794.0**	**152.6**	**112.0**

* Metric Tons of Carbon Dioxide Equivalent (units were standardized to metric tons CO_2 eq, as each country reports in different units.
** On-road includes light-duty gasoline and diesel trucks and vehicles, motorcycles as well as heavy-duty gasoline and diesel vehicles.
*** Data for all three countries in the same year are not available. † No data available for this classification.
Source: U.S. Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions And Sinks: 1990-2007. April 2009. http://www.epa.gov/climatechange/emissions/usinventoryreport.html. Environment Canada. Canada's 2006 Greenhouse Gas Inventory, Report Summary. http://www.ec.gc.ca/pdb/GHG/inventory_report/2006/tab_eng.cfm. Instituto Nacional de Ecología. Inventario Nacional de Emisiones de Gases de Efecto Invernadero 2002. http://www.ine.gob.mx/cpcc-lineas/640-cpcc-inventario-3.

Table 1 above, would represent some 28% of that. The US transportation sector's contribution amounts to 1,794.0 million Mt CO_2eq and approximately 25% of this (452.9 million Mt CO_2eq) is produced by heavy-duty gasoline and diesel trucks and rail.

The contribution of heavy-duty truck and rail to Canada's overall transportation sector CO_2 emissions are proportionally higher than in the United States (38% versus 25%) but of course the absolute amount produced is much less (51.7 million Mt CO_2eq). Mexico lacks specific data that would allow an exact breakdown of its on-road vehicle emissions, but if one conservatively assumes a similar percentage contribution to that of the United States (25%), that would indicate a GHG contribution (based also conservatively on the country's 2002 emission inventory) of 28 million Mt CO_2eq from heavy-duty trucks and rail.

GHG Trends from Transportation

US GHG emissions from the transportation modes are 12 times larger than those in Canada, and 16 times larger than in Mexico. Trends in the United States and Canada are similar, with emissions from passenger cars and light-duty trucks decreasing, while emissions from heavy-duty freight trucks are increasing in recent years (Figure 4).

Measuring / Estimating GHGs

The fact is that what is not measured cannot be controlled. Methods, models, and ensuing user tools that can estimate GHG emissions vary in their ability to address a range of different types of inputs and analyses, such as in the transportation source(s) they address, level of sophistication, scope (direct or life-cycle), geographical level (national, regional, state, or local) and so on. The primary limitation of these types of tools is that the user may either not have access to solid data inputs or may not understand the assumptions tied to the default data.

Current GHG Models

Typically, models estimate direct GHG emissions, which are defined as the GHGs emitted during

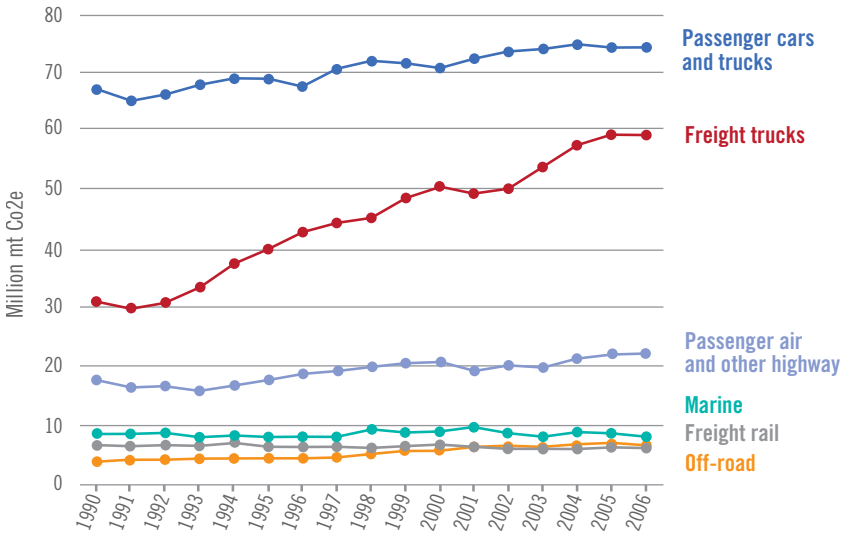

Figure 4. Canada Transportation GHG Emissions by Mode, 1990–2006

Source: Environment Canada. Canada's 2006 Greenhouse Gas Inventory, Report Summary. http://www.ec.gc.ca/pdb/GHG/inventory_report/2006/tab_eng.cfm. Accessed December 2009.

vehicle operation and maintenance. They typically do not consider energy and emissions used or produced during vehicle and fuel production or infrastructure construction, which are other stages that might be considered in a vehicle life-cycle assessment approach (LCA).

Methods and models that can calculate GHG emissions from transportation modes are based on fundamental approaches which can be applied at any geographic level (national, regional, state, or local), or mode, as allowed by the input data. Bottom-up Approach: user-provided data, e.g., vehicle miles traveled (VMT), are combined with developed emission factors, such as grams of CO_2 per VMT, in order to arrive at emissions estimates for an on-road vehicle fleet, such as truck VMT.

- Top-down Approach: vehicle fleet characteristics and fuel consumption by fuel type is allocated to each transportation mode, and to sub-categories within each mode. The corresponding GHG emissions are calculated as a function of each fuel's carbon content.

The models developed by the US EPA for estimating highway mobile source emissions of volatile organic compounds, nitrogen oxides, carbon monoxide, and particulate matter, especially the new MOVES2010, or EMFAC2007 (used in California), or the variations of MOBILE 6.2 developed by Canada and Mexico, use a bottom-up approach.[3] GHG emissions from rail as well as truck freight modes have been addressed in all three countries through the top-down approach by the development of national emissions inventories.

Strategies to Mitigate GHG Emissions

Reducing GHGs from freight transportation modes may be more difficult than reducing GHGs from passenger transportation modes or stationary modes due to several reasons:

- Unlike passenger transportation modes, there is little or no discretionary freight movement
- Impacts on freight transportation have substantial implications for the economy and global competitiveness
- Vehicle fleet turnover occurs more slowly for freight vehicles, slowing down the potential to reduce GHGs by introducing new technologies
- Due to economic competition, freight carriers already have significant incentive to minimize fuel costs (and thereby GHG emissions)
- Freight transportation VMT are expected to grow faster than passenger transportation VMT.

Despite these inherent difficulties, strategies that can mitigate GHG emissions from freight truck and rail transportation modes have been identified. These strategies are explained in detail in Figure 5 and Table 2.

A Summary of North American Programs and Policies to Mitigate GHG

There are three approaches to an emissions reduction mission: regulation, enticement, and market-based. They are promulgated by national or multinational policies, usually commencing at the enticement stage and gradually progressing to the regulatory stage. (Market-based mechanisms have not thus far been used at any national level in North America; however, there is increasing evidence that they will be in the future, much as they have under a few regional and state initiatives.) All three approaches are often drivers for technology development, and technology development, in turn, can expand possibilities for further emissions reductions.

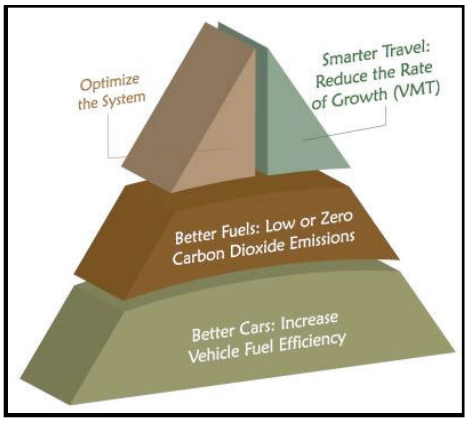

Figure 5. The GHG Emission Reduction Strategies Pyramid

Source: American Association of State Highway and Transportation Officials. Real Transportation Solutions for Greenhouse Gas Emissions Reductions. http://realsolutions.transportation.org/Pages/default.aspx. Accessed November 2009.

3. US EPA. EPA Releases MOVES2010 Mobile Source Emissions Model: Questions and Answers. Office of Transportation and Air Quality EPA-420-F-09-073. December 2009.

Table 2: Summary of Truck and Rail GHG Mitigation Strategies

Strategy	Truck	Rail
Fuel Technologies	■ Biodiesel ■ Compressed natural gas (limited applications) ■ Plug-in hybrids	■ Ultra-low sulfur diesel ■ Electrification ■ Biodiesel ■ Compressed natural gas
Vehicle Technologies	**Fuel Efficiency** ■ Auto tire inflation systems ■ Low-rolling resistance tires ■ Wide tires ■ Aerodynamic improvements ■ Low-viscosity lubricants ■ Lighter tractors and trailers ■ Improved AC systems ■ Waste heat recovery	■ Track lubricants ■ Low-friction bearings ■ Light weight cars ■ Lubrication improvement ■ B20 biodiesel
	Idle Reduction ■ Bunker heaters ■ Auxiliary power units ■ Automatic shut down/start up systems ■ Electrified truck stops ■ Idle reduction policies	■ Auxiliary power units ■ Diesel heat system ■ Automatic engine start/stop ■ Switchyard idling restrictions ■ Plug-in units
	Retrofit/Replacement* ■ Diesel oxidation catalysts ■ Diesel particulate filters ■ Selective catalytic reduction systems ■ Engine upgrade/replacement e.g. direct injection, reduced engine friction, waste heat recovery ■ Truck replacement with newer or hybrid vehicles	■ Locomotive replacement with newer cleaner units ■ Hybrid rail yard switchers ■ Locomotive rebuilding
System Optimization / Operational Efficiency	■ Pick-up & delivery idling reduction measures ■ Congestion mitigation measures ■ Speed restrictions ■ Arterial signal synchronization ■ Grade crossing separation ■ Driver ecodriving education ■ Reduced empty mileage & circuitous routes ■ Longer/Heavier Combination Trucks ■ Advance clearance ■ Advanced technology and logistics ■ Movement optimization ■ Intermodalism ■ Mode shift to water or rail ■ Port access improvements	■ Switchyard idling reduction measures ■ Rail congestion mitigation measures ■ Line-haul speed restrictions ■ Reduced empty mileage ■ Longer & double stacked trains ■ Train clearance improvement ■ Elimination of circuitous routes ■ Advanced technology and logistics ■ Movement optimization ■ Intermodalism ■ Mode shift to water ■ Port access improvements
Smart/ Sustainable Growth	■ Reduction of rate of growth of VMT through improved and integrated transportation planning that accounts better for freight movements	
Market-based Mechanisms (Future)	■ Emissions controls, e.g., cap-and-trade ■ Emissions pricing, e.g., carbon tax *Pricing emissions will offset cost of abatement and achieve emissions reductions*	

* Emission control retrofit devices can only reduce non-CO_2 GHG emissions

Although impressive technological advancements have occurred, primarily spearheaded by the private sector, there seems to be a lack of adequate infrastructure and strong governmental push to put these technologies into commercial use. While there are several initiatives that address GHGs from stationary sources and transportation in broad contexts, only a handful of those initiatives cater specifically to the freight sector. Furthermore, programs targeting freight truck and rail GHG emissions tend to originate at the national level and be disseminated to lower government levels on project bases, most likely due to the heavy public investment requirements.

The US and Canada signed an Air Quality Agreement in 1991, which facilitated several joint border air quality projects and studies as well as initiatives for technology transfer and exchange. In both countries mandatory reporting of GHGs at a national level has recently been promulgated but only applies to large stationary emitters—e.g., power plants and factories. Two regional initiatives that cross the US-Canada boundary are the Western Climate Initiative (WCI) and the Midwestern Greenhouse Gas Reduction Accord (MGGRA).

Private transboundary initiatives include Empty Miles program, a US-Canada originated solution to optimize truck transportation by matching potential loads to reduce the number of empty trailers.

The EPA is responsible for preparing the US Inventory of Greenhouse Gases. In January 2010, EPA put into effect the Mandatory Reporting of Greenhouse Gases Rule, in response to the American Clean Energy and Security Act, a cap-and-trade bill passed in June 2009.

- The Regional Greenhouse Gas Initiative (RGGI) does not cross national boundaries but is the first mandatory US cap-and-trade program for CO2 and includes ten Northeastern and Mid-Atlantic states.
- EPA's SmartWay Transport Partnership among government, business, and consumers aims to protect the environment, reduce fuel consumption, and improve air quality. Business partners include shippers, truck & rail carriers, logistics companies, and truck stops. Benefits to the private sector include cost savings, business-to-business advantage, environment achievement, and public and peer recognition.
- The National Clean Diesel Campaign (NCDC) was created by the Diesel Emissions Reduction Act (DERA) and also funded through the American Recovery and Reinvestment Act (ARRA). NCDC consists of four components which provide funding to reduce emissions from existing diesel engines through various strategies, including encouraging existing fleets to adopt cleaner technologies.
- The Congestion Mitigation and Air Quality (CMAQ) Improvement Program is jointly administered by the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) and funded by SAFETEA-LU. States, MPOs and transport agencies in nonattainment areas can invest in surface transportation projects that result in better air quality and reduced congestion. Freight GHG emissions reductions related eligible projects include alternative fuels, diesel retrofits, anti-idling facilities and truck stop electrification, and general and intermodal freight projects.
- The Department of Energy's (DOE) 21st Century Truck Partnership has a vision for developing a freight and passenger transport system that is least polluting

and reduces dependence on foreign oil. It invests and focuses on higher-risk research and development of energy-saving fuel and vehicle technologies for heavy duty trucks. Several high profile companies, government agencies and national research laboratories are involved.

- America's Marine Highway Program aims to expand the use of America's Marine Highways. The program currently faces obstacles such as economic competitiveness concerns related to waterways and subsequent unwillingness of shippers to divert. Other obstacles include service and marketing issues, operating cost, infrastructure and equipment issues, government and regulatory issues, operational constraints, and vessel-related issues.
- EPA also supports state efforts to develop GHG inventories, develop State Climate Change Action Plans, and implement policies and programs by providing guidance, tools and technical assistance. EPA also assists local governments in similar ways.
- Efforts of individual freight facilities, such as the Ports of Southern California (Los Angeles/Long Beach), include operation of an off-peak cargo program (PierPass) to provide an incentive for cargo to be moved at night and on weekends, in order to reduce truck traffic and pollution during peak daytime traffic hours and to alleviate port congestion. The Ports have also launched Clean Truck Programs to gradually phase out and ban all trucks not meeting 2007 Federal Clean Truck Emission Standards by 2012, as part of the Clean Air Action plan which targets major air polluting sources in the two ports: trucks, trains, ships, cargo handling units, and harbor craft.
- Environment Canada prepares Canada's annual GHG emissions Inventory. In March 2004, the Government of Canada announced the introduction of mandatory reporting of GHG emissions by the largest industrial GHG emitters.
- FleetSmart is Natural Resources Canada's SmartWay equivalent and a component of the ecoTRANSPORT umbrella program. Its purpose is to introduce heavy-duty truck fleets to energy-efficient practices that can reduce fuel consumption and emissions. Official cooperation exists between EPA and NRC to offer tools, resources, and guidance to fleet owners on energy-efficient vehicles and business practices to reduce fleet operating costs, improve productivity, and increase competitiveness. NRC also provides funding to heavy-duty truck owners for retrofitting their rigs with EPA-certified emissions control devices, similarly to the US's NCDC.
- EcoTRANSPORT also encompasses ecoFREIGHT, run by Transport Canada, and consists of six initiatives: Freight Technology Demonstration Fund; Freight Technology Incentives Program; Marine Shore Power Program; National Harmonization Initiative for the Trucking Industry; ecoFREIGHT Partnerships; and ecoENERGY for fleets. The government-industry collaboration has led to voluntary agreements with freight industry associations such as Railway Association of Canada that include emission reduction targets, action plans to achieve those targets, and reporting on progress.
- Sustainable Development Technology Canada (SDTC) is a nonprofit foundation that funds transportation-related (including freight) projects through public and private sector collaborations, i.e., industry, academia, nongovernmental organizations (NGOs), the financial community and all levels of government.
- Canada has developed a National Policy Framework for Strategic Gateways and Trade Corridors and individual Gateway Strategies to serve as frameworks for long-term planning and strategic investment, optimization of existing transportation infrastructure, better integration of major transportation systems, environmental protection, and enhancing transportation security.
- The Gateways and Border Crossings Fund (GBCF) is a merit-based program to fund transportation infrastructure and other related initiatives along Canada's strategic gateways, trade corridors and border crossings and to better integrate the national transportation system. Key objectives are enhanced transportation system efficiency, reliability and integration, and innovative technology applications designed to improve and maximize system capacity, eliminate bottlenecks, and optimize the use of all transportation modes. GBCF investments include intermodal connections, shortline railways and short sea shipping to mitigate congestion and minimize environmental impacts of transportation e.g. emissions and land-use.
- Canada's provinces and territories collaborate on efforts to reduce energy consumption within the freight transportation sector, and released a Guide for Purchasing Aerodynamics for Heavy-Duty Tractors and Trailers. Québec is taking particular action, both by implementing measures to reduce GHG emissions and adapting to the impacts of climate change on transportation, through programs and actions geared towards energy efficiency, public/alternative transit and intermodal transportation, technological innovation, and public awareness.

Mexico made a strong effort towards climate change in December 2008, when it announced it had set the goal of reducing GHG emissions to 50% below 2002 levels by 2050. Mexico's GHG program, "Programa GEI Mexico" is a voluntary GHG accounting and reporting program with several industry participants. Several occasions of technical collaboration with the EPA led to Mexico's National Emissions Inventory in 1999 for criteria pollutants, currently being updated with 2005 data; the 1990-2002 National GHG Inventory; and the MOBILE6-Mexico emission factor model. In addition, a new, low carbon bus rapid transit and light rail system using low carbon alternatives was introduced in Mexico City with plans for expansion to other cities.

With a view to helping the NAFTA partners improve the environmental performance of freight transportation in North America while contributing to the region's competitiveness, the Commission for Environmental Cooperation (CEC) Secretariat's latest independent study under Article 13 of the North American Agreement on Environmental Cooperation will profile the current environmental status of freight transportation in North America and look at opportunities for improving its environmental sustainability at a time of major infrastructural development along its trade corridors.

The study will focus on greenhouse gas emissions and energy consumption related to freight transportation, with a focus on rail and trucking modes.

With the assistance of an advisory group of representatives from transportation industries, nongovernmental organizations, and government agencies, the study will evaluate scenarios for improving the environmental performance of freight transportation by 2030 and recommend policy pathways to achieve those goals.

Those recommendations will encourage the development of policies and other measures to ensure that North American freight transportation systems are developed in an efficient, competitive and environmentally sustainable manner.

For complete details, please visit: **www.cec.org/freight**

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