PART OF THE PROBLEM OR PART OF THE SOLUTION?
HOW CANADA'S RAILWAYS CAN HELP ADDRESS CLIMATE CHANGE

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Introduction

The twenty-first Conference of the Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC) marked a pivotal moment in Canada's climate change history. COP 21 provided the forum where Canada underscored its desire to take on a leadership role in the international climate change environment, with the Prime Minister noting in his opening remarks "Canada is back, my friends," and "We're here to help"[i].

Canada's engagement in COP 21 and the statements made by the Prime Minister reaffirm the country's commitment to combating climate change, and the federal government's intentions to play a more instrumental role in driving down emissions in Canada and abroad. Canada plans to reduce its greenhouse gas (GHG) emissions by 30 per cent below 2005 levels by 2030[ii].

In cooperation with 194 other countries and the European Union, Canada adopted the Paris Agreement at COP 21. This agreement, signed on December 12, 2015, formalizes the country's commitment to strengthen the global response to climate change by[iii]:

> "holding the increase in the global average temperature to well below 2 °C above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change".

Labelled as the world's first universal climate change agreement, the text includes reduction commitments for both developed and developing countries. Unlike the Kyoto Accord, the agreement takes an all-in approach rather than rely on the performance of 37 countries. It includes provisions to provide financial assistance to developing countries to implement new procedures to minimize climate change.

Prior to COP 21, and in the absence of a national strategy to address GHG emissions in Canada, four provincial governments have moved forward with their carbon management strategies. Although these strategies differ in terms of their scope and implementation mechanisms, they strive to introduce a price on carbon as means to reducing GHGs and moving towards a low-carbon economy. An overview of the existing provincial strategies and their approach to addressing transportation-related emissions is provided below.

British Columbia

Established in 2008, British Columbia (BC) is implementing a carbon tax that applies to GHG emissions associated with the combustion of fossil fuels. It initially introduced at tax rate of $10 per tonne per tonne of carbon equivalent (i.e. CO_{2e}) which has gradually increased to $30 per tonne. The tax applies to approximately 70 per cent of the provinces GHGs including liquid fuels and large industrial emitters.

Administratively, the carbon tax is implemented similarly to a motor fuel tax. Since different fuels generate different amounts of GHG when burned, $30 per tonne of CO_{2e} must be translated into a tax rate

for each type of fuel. As of July 2012, the carbon tax per unit applied to gasoline, diesel (i.e. light oil fuel) and natural gas is respectively 6.67 cents per litre, 7.67 cents per litre and 5.70 cents per cubic metre[iv].

Alberta

Coming into force in 2007, Alberta's *Specified Gas Emitter Regulations* introduced a downstream-like approach that combines a tax and cap and trade system to managing carbon. This approach establishes a GHG intensity standard of 12 per cent improvement per year on large industrial emitters, including oil and gas facilities. Compliance can be attained through a number of initiatives including: the buying or selling of emission performance credits at $15 per tonne, using offsets, or paying into a Technology Fund. Under this arrangement, 50 per cent of the province's emissions are captured, and there are no specific provisions for the transportation sector.

However in November 2015, the Premier of Alberta introduced a new Climate Leadership Plan that will include a cap on oil sand emissions and regulations to reduce methane produced by the sector, the phasing out of coal-fired electricity, and a carbon tax[v]. More specifically, the oilsands emissions limit will be set at 100 megatonnes (MT) and emissions produced by coal are expected to be fully phased out by 2030. For all other sectors, a carbon tax of $20 per tonne is scheduled to be introduced in January 2017 followed by an increase to $30 a tonne in January 2018[vi]. Similar to BC, the carbon tax will apply to fuel bought and sold within the province.

Ontario

Building on its successful phase-out of coal fired electricity, Ontario's Climate Change Strategy sets out the province's vision for combating climate change and achieving its GHG targets for 2020, 2030, and 2050[vii]. The cornerstone of this strategy is a cap and trade system.

Announced in April 2015, the government stated that it will join the cap and trade system under the Western Climate Initiative, Inc., partnering with other jurisdictions, including Quebec and California[viii]. The system, currently under development, is intended to capture process emissions from facilities that produce more than 25,000 tonnes of carbon, as well as combustion emissions produced by specific segments of the transportation sector[ix].

Similar to Quebec's cap and trade system (described below), transportation fuels are covered at the distribution level when they are first placed into the market. Volumes of 200 litres of fuel or more, regardless of whether they come from within or outside of the province, are subject to the system providing that the fuel is delivered to a customer in Ontario[x]. Transportation carriers are not subject to a cap on their emissions.

It is expected that Ontario will mirror the system in Quebec and will exempt fuel from the aviation and shipping sectors[xi]. Emissions from these sectors have been exempt from provincial systems as a result of the precedent set during the Kyoto Accord negotiations, which delegated the responsibility to limit and reduce international aviation and shipping emissions to specialised agencies within the United Nations – namely the International Civil Aviation Organisation and the International Maritime Organization[xii].

The cap and trade system is expected to come into force in 2017 and is estimated to cover approximately 80 per cent of the province's emissions[xiii].

Quebec

Building on the carbon levy that came into force in 2007 and introduced a charge on liquid fuels including gasoline (0.8 cents) and diesel fuel (0.938 cents), the government of Quebec revised its approach to managing GHGs when it launched the cap and trade system in January of 2013[xiv].

Implementation of the system has occurred through two periods. The first, spanning 2013 and 2014, applied to industrial and electricity production facilities that emit 25,000 tonnes or more of CO_{2e} a year. The second, spanning 2015 to 2017 includes the addition of fuel importers and distributors that provide fuel for consumption in the transportation and building sectors. As previously discussed, fuel used in the transportation sector is captured when fuel first enters the market.

This system covers 85 per cent of the province's emissions and places a price on carbon at $15 per tonne.

Federal Initiatives

At the federal level, policies have been ad-hoc and have focussed on engine manufacturing and alternative fuel standards. For example, the *Federal Passenger Automobile and Light Duty Truck Emissions Regulations* require all new vehicles purchased after 2011 to achieve an emission standard of 348 grams of CO_{2e} per mile travelled by 2016[xv]. In combination with this is a federal renewable fuel standard requiring 5 per cent ethanol in gasoline[xvi]. While these policies are estimated to reduce emissions by more than 30 MTs by 2020, they were created in isolation and not as part of a coordinated federal-provincial strategic approach to addressing emissions in Canada.

Table 1 provides a summary of emissions by major sector in Canada as well as in the provinces that have carbon management strategies. A breakdown of transportation-related emissions is also included.

Table 1: Climate Change Strategies in Canada

	British Columbia	**Alberta**	**Ontario**	**Quebec**	**Federal**
Model	Carbon Tax	Carbon Tax	Cap & Trade	Cap & Trade	-
2013 Emissions in kilotonnes of CO_{2e}	62,800 (21.0% over 1990 levels)	267,000 (52.6% over 1990 levels)	171,000 (6.0% under 1990 levels)	82,600 (8.0% under 1990 levels)	726,000 (18.4% over 1990 levels)
Reduction Target	33% below 2007 levels by 2020, 80% below 2007 levels by 2050	Reduction of 50 MT by 2030	15% below 1990 levels by 2020, 37% below 1990 levels by 2030	20% below 1990 levels by 2020, 37.5% below 1990 levels by 2030	30% below 2005 levels by 2030
Emissions Breakdown – 2013 (in kilotonnes of CO_{2e})	Energy (Except Transportation): 27,400 Transportation: 24,800 Industrial Processes and Product Use: 3,400 Agriculture: 2,300 Waste: 4,800	Energy (Except Transportation): 188,800 Transportation: 44,200 Industrial Processes and Product Use: 13,500 Agriculture: 19,000 Waste: 2,300	Energy (Except Transportation): 69,800 Transportation: 61,200 Industrial Processes and Product Use: 20,500 Agriculture: 10,000 Waste: 9,000	Energy (Except Transportation): 23,900 Transportation: 34,900 Industrial Processes and Product Use: 10,800 Agriculture: 7,800 Waste: 5,300	Energy (Except Transportation): 384,000 Transportation: 204,000 Industrial Processes and Product Use: 52,200 Agriculture: 60,000 Waste: 25,000 Land Use and Forestry: -15,000
Transportation Sector Breakdown – 2013 (in kilotonnes of CO_{2e})	Domestic Aviation: 1,300 Road Transportation: 15,900 Railways: 540 Domestic Navigation: 2,200 Other Transportation: 4,800	Domestic Aviation: 1,500 Road Transportation: 23,700 Railways: 990 Domestic Navigation: NA Other Transportation: 16,000	Domestic Aviation: 2,300 Road Transportation: 46,100 Railways: 1,300 Domestic Navigation: 1,200 Other Transportation: 10,000	Domestic Aviation: 730 Road Transportation: 27,300 Railways: 880 Domestic Navigation: 960 Other Transportation: 5,100	Domestic Aviation: 7,500 Road Transportation: 137,000 Railways: 7,400 Domestic Navigation: 5,300 Other Transportation: 47,000

Source: 2015 National Inventory Report – Part 3.

Potential implications to the railway sector

While nearly 30 per cent of Canada's GHG can be attributed to the transportation sector[xvii], the policy approach to addressing emissions within the sector has been fragmented and developed in a bit-part way. Only four of ten provinces have a policy regime in place to address emissions, of which three apply (or intend to apply) cap and trade mechanisms and one relies on taxation. In Ontario and Quebec, certain segments of the aviation and shipping industries are excluded entirely.

For railway carriers with operations spanning multiple political boundaries, the resulting effect is a requirement to participate in a series of regional initiatives that lack cohesion and have been brought forward in uncoordinated way.

Under all systems, a railway is subject to compliance costs as a fuel user. While program compliance costs under a cap and trade system (e.g. the purchase of emission units or offsets) are initially absorbed by fuel wholesalers or distributors, they are typically passed on to the customer, in this case, the railway[xviii]. However, there are two scenarios where a railway can be subject to program compliance costs directly: first, when they purchase their fuel directly from a refinery; or second, when they import fuel from the U.S in a volume that is above the statutory threshold (e.g. 200 litres). Inevitably the price of fuel increases for railways and their customers.

None of the existing initiatives contain specific provisions to incent modal shift, and as a result, it remains to be seen as to whether these approaches will encourage shippers and people to choose the lowest GHG-emitting mode of transportation to move their products to market or themselves to work.

Railway emission performance in Canada

Canada's railway industry has a long history of working with the federal government to reduce emissions produced by locomotives. Since 1995, the industry has held a series of Memorandum of Understanding (MOU) with the Federal Minister of Transport that have provided the platform for identifying pragmatic solutions for reducing emissions. The sector is currently working through its third MOU which establishes voluntary GHG emission reduction targets from 2011 to 2016 for Class I freight, shortline, and intercity passenger railways[xix]. All signatory railways report their GHG and CAC performance annually, and performance reports are peer reviewed and available to the public.

Performance under the MOU agreements has been positive with railways demonstrating that investments in technology and more efficient operating practices are improving fuel economy and reducing emissions. Investments in new Tier-locomotives, anti-idling devices, and trip-optimization software have reduced emissions, while innovative operational practices such as distributed power and the use of longer, heavier trains have helped achieve optimal results. Table 2 includes a list of common technologies and management strategies used by railways to reduce their emissions.

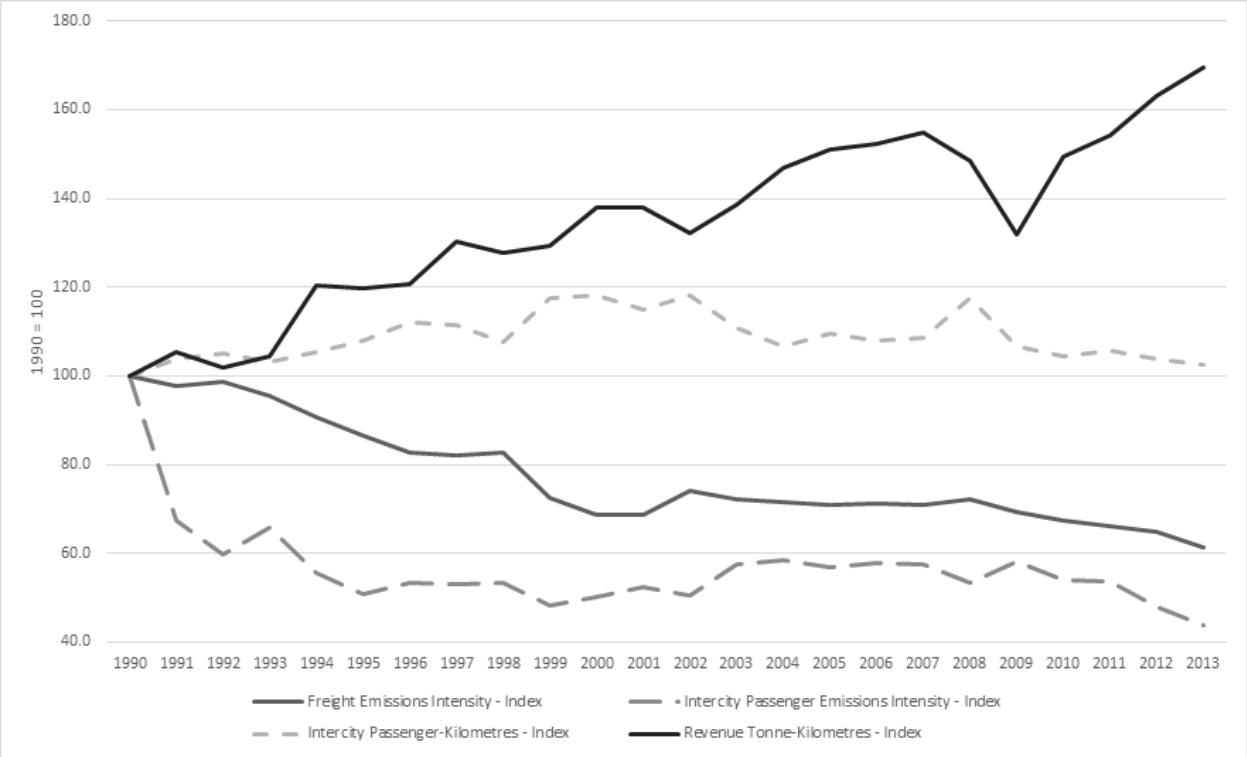
Table 2: Technologies and Management Strategies Used by Railways to Reduce Emissions

Longer Trains	Use of Ultra-Low Sulphur Diesel Fuel
Dynamic Brakes	Engine Retrofits
Anti-Idling Devices	Distributed Power
Rail Lubrication	Trip Optimizer Technology
Top-of-Rail Friction Control	Yard Optimization Practices

Figure 1 highlights that freight railways have reduced their GHG intensity (kg of CO_{2e} per 1,000 revenue tonne-kilometer) by nearly 40 per cent since 1990, while experiencing a 91.5 per cent increase in revenue-tonne-kilometers[xx]. Similarly intercity passenger railway emissions (kg of CO_{2e} per passenger-kilometer) have decreased by approximately 56 per cent while ridership has increased by 2 per cent[xxi]. However,

since 2001, the exceptional growth of the commuter railway industry in Vancouver, Toronto and Montreal, and the need to offer commuter trains at non-peak times, has led to an increase of emissions (kg of CO_{2e} per passenger) of approximately 31 per cent, while traffic has increased by 46.5 per cent since.

Figure 1: GHG Emissions Intensity for Canadian Railways – 1990-2013



In addition to their participation under the MOU, CN and CP are active participants in the internationally recognized Carbon Disclosure Project (CDP). Created in the United Kingdom in 2000, the CDP encourages greater transparency about greenhouse emissions produced by corporations, as well as disclosure of a company's climate change strategy and targets to reduce GHGs. The CDP holds the largest collection of self-reported climate change data in the world with nearly 2,000 businesses reporting climate change data to the organization in 2014. In 2015, both CN and CP were awarded positions on the Canada Climate Disclosure Leadership Index in recognition of their efforts to disclose high quality carbon emissions and energy data to the CDP's climate change program[xxii].

Challenges to reducing emissions in the rail sector

While railways have demonstrated their ability to reduce emissions in parallel to increased workloads, performance in the future may occur at a slower pace than previous years. Investments in technology have been positive to date and as of 2013, 71.1 per cent of the total linehaul fleet in Canada was compliant with the U.S. Environmental Protection Agency's regulations for Tier-locomotives, an incredible achievement given that just 5.3 percent of the fleet was compliant with the regulations in 2000[xxiii]. Likewise, 71.1 per cent of all locomotives (linehaul and yard) are equipped with anti-idling devices[xxiv]. The high-level of integration of best available technology suggests that ongoing investments in this area will continue to reduce emissions, but will do so incrementally.

Furthermore, commodity mixes carried by railways are adjusting to new realities and the global demand for Canada's natural resources. The resulting effect is a transition away from traditional heavier

commodities such as coal and metals, and towards lighter commodities such as container traffic. For example from 2005 to 2014, coal and metal car loadings have increased on average of 0.7 per cent per year, while intermodal traffic has increased by 2.1 per cent per year over the same period[xxv]. In general, a lighter commodity portfolio requires more fuel per unit of workload[xxvi].

The transition away from diesel-powered locomotives to alternative fuel sources such as liquefied natural gas (LNG) is also evolving, albeit slowly. In Canada, CN was the first railway in North America to pioneer an LNG-powered locomotive as part of a pilot study from 2012 to 2013 that moved freight between Edmonton and Fort McMurray, Alberta[xxvii]. In the U.S. the Burlington Northern Santa Fe Railway has also piloted an LNG-locomotive[xxviii]. However, long-refuel processes and higher than expected maintenance costs, as well as the recent drop in diesel fuel prices, have stalled the mainstream application of this technology in the railway sector[xxix].

Although emission reductions in the sector are expected to continue in the future, opportunities to invest in existing or emerging technologies such as LNG powered locomotives are limited, and the railway book of business continues to shift towards lighter products and commodities. Collectively this suggests that emission reductions will occur at a slower pace than previous years, and that railways will need work with suppliers and government to identify new solutions to reduce emissions even further.

The Rail Advantage

Despite the challenges noted above, the movement of goods and people by rail is an efficient and GHG friendly mode of transportation. In 2009 the Federal Railroad Administration completed a comparative evaluation of rail and truck fuel efficiency on corridors and services in which both modes compete, with a competitive movement defined as a movement in which mode share is comparable between rail and truck. The evaluation examined 23 freight movements and took into consideration multiple distances and commodities that could be moved by both truck and rail[xxx]. For each movement, fuel consumption for each mode was estimated and circuity was taken into account.

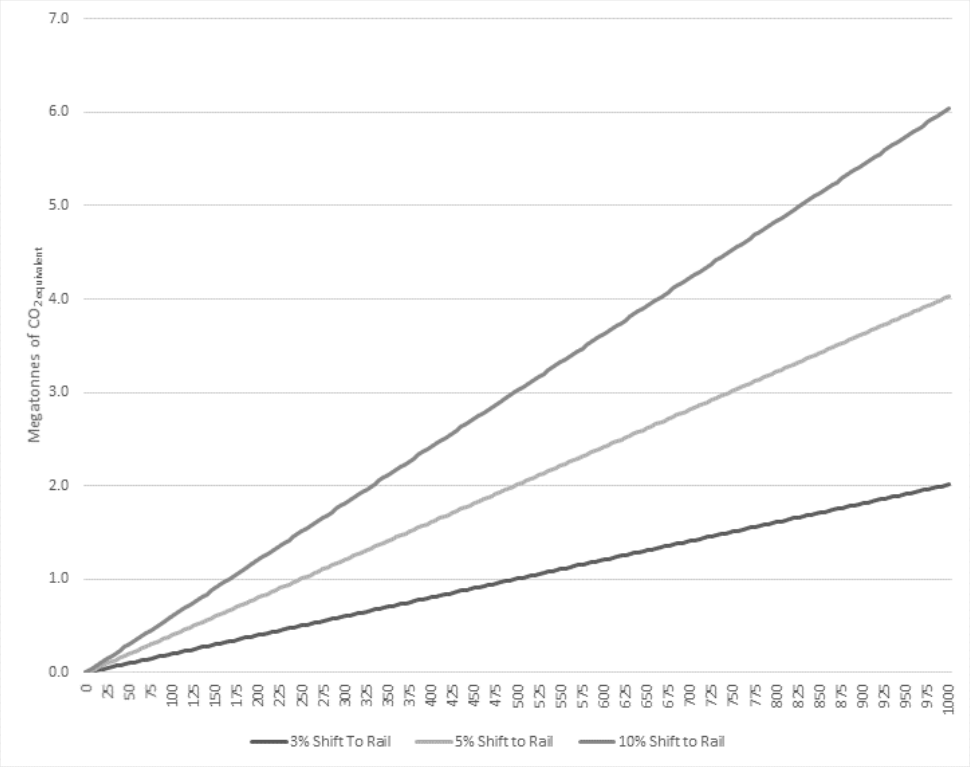
The evaluation concluded that rail was more fuel efficient than truck on all 23 movements and that fuel savings from using rail are significant. With respect to fuel savings, rail fuel efficiency varies from 156 to 512 ton-miles per gallon, while truck fuel efficiency ranges from 68 to 133 ton-miles per gallon[xxxi]. The rail-truck fuel efficiency ratios ranged from 1.9 to 5.5 for all movements (with circuity taken into account) and 0.8 to 8.5 (without circuity), with 3.7 and 3.9 as the respective averages[xxxii] . For movements involving intermodal, the rail-truck fuel efficiency ratio was 4.0. In other words, rail was found to be roughly 4 times more fuel efficient than truck.

In Canada, rail can move one tonne of freight 215 kilometers on a single litre of fuel[xxxiii]. Furthermore, a single freight train is capable of removing over 300 trucks from our road and highway network[xxxiv,xxxv] .

In the absence of a clear policy direction for transportation-related emissions, the potential for reducing GHGs from the increased use of rail are not realized. Figure 2 highlights the potential GHG savings associated with shifting 3, 5 and 10 per cent of truck traffic in Canada to rail. These scenarios incorporate two assumptions: truck traffic is fully transferable to rail and that truck fuel efficiency is 66.55 L per 1,000 revenue tonne kilometer (RTK); and rail fuel efficiency is estimated at 4.95 L per 1,000 RTK[xxxvi, xxxvii].

Since trucks carried 593 million tonnes of freight in 2013[xxxviii], the potential GHG savings for a 3, 5, and 10 per cent shift of truck traffic to rail are estimated to be respectively 1.2, 2.4, or 3.6 MTs of CO_{2e}. Additional benefits include reduced congestion and less wear and tear on the country's road and highway system. By comparison BC's taxation system is estimated to deliver a 3 MT reduction by 2020[xxxix].

Figure 2: Effects of a Modal Shift in Traffic from Trucking to Rail



Policy Considerations for the Future

The GHG advantage that rail maintains over trucking requires deep consideration from policy makers across all levels of government as they contemplate carbon management strategies within their jurisdictions. Although carbon pricing, whether through taxation or a market-based approach, inspires to reduce emissions at the lowest possible cost, questions remain as to whether it will lead to substantive emissions reductions in the transportation sector, while the introductory price per tonne for carbon remains relatively low.

Other instruments to incent shippers and people to make transportation choices on the basis of emissions performance could stimulate the modal shift required to reduce transportation-related GHGs. This paper highlights what can be achieved through modal shift in the freight sector. Other policies such as road pricing and tolling also hold the potential to reduce congestion and lower GHGs, yet these items have yet to be included in any regional climate change strategy[xl].

Similarly, none of the aforementioned climate change policies provide a clear incentive for shippers to review their transportation portfolio and choose the transportation option that emits the fewest GHGs. In this case, a tax credit or carbon-offset system based on modal-shift could provide the right incentive. It is important to note that the Quebec and Ontario cap and trade systems allow for carbon offsets, however only sectors that are not subject to the cap and trade system (e.g. organic waste management, forest projects, etc.) can support the development of carbon offsets[xli]. As a result railways cannot create an offset credit for a shipper that chooses to move their products from truck to rail.

Looking forward, policy makers should consider rail as part of the climate change solution rather than the climate change problem. For example, the Government of Quebec recognizes the significant GHG savings that rail can deliver and has assured that revenues generated from its cap and trade system are directed towards the Green Fund. This fund is designed to support the province's sustainable development and climate change objectives through policies implemented by the Minister of Sustainable Development, Environment and Parks and other Ministries such as transport[xlii].

For example, a portion of the Green Fund has been allocated to the Ministry of Transport, Sustainable Mobility and Transport Electrification to implement two programs: the program for the reduction or avoidance of greenhouse gas emissions through the development of intermodal transport (PREGTI); and the program to improve the efficiency of maritime, air and rail in reducing greenhouse gas emissions (PETMAF)[xliii]. PREGTI aims to reduce or avoid GHGs generated by the transportation of goods and people through by creating intermodal projects and the promoting the use of rail and marine transportation. PETMAF strives to reduce or avoid GHG emissions generated by shipping, air and rail, including the use of equipment and more efficient transport equipment energy-and the use of energy emitting fewer GHGs.

Both programs demonstrate how public revenues generated from carbon policy programs can be used to encourage the use of rail, with the PREGTI program recognizing rail as a means to achieving a low-carbon society, and the PETMAF program focused on identifying additional GHG opportunities within the rail sector. Combined, the programs offer approximately $60 million from 2013 to 2017.

Conclusion

In his opening remarks to COP 21, the Prime Minister acknowledged that there is a need for the federal government to work with provinces, territories, cities and Indigenous leaders in order for Canada to achieve its targets and become a climate change leader[xliv]. As a first step federal and provincial Ministers of the Environment met in Ottawa on January 29, 2016 – the first time in a decade – to discuss a preliminary approach to developing a pan-Canadian framework for combatting climate change[xlv]. This discussion is expected to continue at the first Ministers meeting in early March when the Prime Minister and provincial Premiers are expected to build the foundation for this plan[xlvi].

The railway sector hopes that this plan will recognize three fundamental items. First, that the approach to managing transportation-related emission in Canada is fragmented and is moving forward without a national vision for reducing carbon within the sector. Second, that existing provincial-based systems fail to address all transported-related emissions and do not acknowledge that these emissions span air sheds that cross multiple political jurisdictions. Third, that the new federal direction will recognize the potential role railways can play in reducing emissions - just like the Government of Quebec has done in shaping its Green Fund.

Looking forward governments should recognize the vast potential of rail and its ability to be an integral part of their climate change solutions and approaches to transitioning towards a low-carbon society.

[i] Government of Canada, 30 November, 2015, Canada's National Statement at COP 21, available from: http://pm.gc.ca/eng/news/2015/11/30/canadas-national-statement-cop21
[ii] Government of Canada, May 15 2015, Government of Canada Announces 2030 emissions target, available from: http://news.gc.ca/web/article-en.do?nid=974959
[iii] United Nations Framework Convention on Climate Change, Paris, 12 December 2015, Adoption of the Paris Agreement, FCCC/CP/2015/L.9, p. 2, available from: https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf
[iv] Government of British Columbia, July 2015, Ministry of Finance, Tax Rates on Fuels Bulletin MFT-CT 005, available from: http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm
[v] Government of Alberta, 22 November 2015, Climate Leadership Plan, available from: http://www.alberta.ca/climate-leadership-plan.cfm
[vi] Government of Alberta, 22 November 2015, Climate Leadership Plan – Carbon Pricing, Available from: http://www.alberta.ca/climate-carbon-pricing.cfm
[vii] Government of Ontario, 24 November 2015, Ontario's Climate Change Strategy, available from: https://www.ontario.ca/page/climate-change-strategy
[viii] Government of Ontario, 13 April 2015, Cap and Trade System to Limit Greenhouse Gas Pollution in Ontario, available from: https://news.ontario.ca/opo/en/2015/04/cap-and-trade-system-to-limit-greenhouse-gas-pollution-in-ontario.html
[ix] Government of Ontario, 16, November 2015, Cap and Trade Program Design Options (slide 20), available from: https://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTI2NTI2&statusId=MTkwOTcw
[x] Ibid.
[xi] Government of Quebec, 1 January 2016, Regulation respecting a cap-and-trade system for greenhouse gas emission allowances (s.2), chapter Q-2, r. 46.1, available from: http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=3&file=/Q_2/Q2R46_1_A.HTM
[xii] United Nations Framework Convention on Climate Change, 2014, Emissions from fuel used for international aviation and maritime transport, available from: http://unfccc.int/methods/emissions_from_intl_transport/items/1057.php
[xiii] H. Pearson, personal communication, 4 March 2016.
[xiv] Government of Quebec, A brief look at the Quebec Cap-and-trade system for emission allowances, available from: http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/in-brief.pdf
[xv] Government of Canada, 3 February 2016, Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations (SOR/2010-201) (S.14(4c), available from: http://laws-lois.justice.gc.ca/eng/regulations/SOR-2010-201/FullText.html
[xvi] Environment and Climate Change of Canada, 3 February 2015, Renewable Fuels Regulations (SOR/2010-189) (Part 1, 5(1), available from: http://laws-lois.justice.gc.ca/eng/regulations/SOR-2010-189/FullText.html
[xvii] Environment Canada, 17, April 2015, National Inventory Report (Part I, p.21), available from: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php
[xviii] Ontario Ministry of Environment and Climate Change, 16 July 2015, Liquid Fuels Coverage in Cap and Trade (slide 16).
[xix] Railway Association of Canada, 30 April 2013, Memorandum of Understanding between Transport Canada and the Railway Association of Canada for Reducing Locomotive Emissions (Section1), available from: http://www.railcan.ca/assets/images/TC_RAC_MOU_2011-2015_EN.pdf (note MOU was extended to 2016 in December 2015)
[xx] Railway Association of Canada, 17 December 2015, Locomotive Emissions Data 1990 – 2013, available from: http://www.railcan.ca/assets/images/publications/LEM/LEM_2013/2013_LEM_Report_-_Tables_Public.zip
[xxi] Ibid.
[xxii] Carbon Disclosure Report, 1 November 2015, CDP Climate Change Report 2013 Canada 200 Edition (p. 15), available from: https://www.cdp.net/CDPResults/CDP-canada-climate-change-report-2015.pdf
[xxiii] Railway Association of Canada, 1 December 2015, Locomotive Emissions Monitoring Report (p.22), available from: http://www.railcan.ca/publications/emissions
[xxiv] Ibid, (p.23)
[xxv] Railway Association of Canada, 1 December 2015, Rail Trends 2015 (p.6), available from: http://www.railcan.ca/publications/trends
[xxvi] Federal Railroad Administration, 19 November 2009, Comparative Evaluation of Rail and Truck Fuel Efficiency on Competitive Corridors (p.22), available from: https://www.fra.dot.gov/eLib/details/L04317
[xxvii] CN, 27 September 2012, CN tests natural gas/diesel fuel powered locomotives between Edmonton and Fort McMurray, Alta., available from: http://www.cn.ca/en/news/2012/09/media_news_cn_tests_natural_gas_locomotives_20120927
[xxviii] Burling Northern Santa Fe Railway, 22 February 2016, Alternative Fuels, available from: http://www.bnsf.com/communities/bnsf-and-the-environment/alternative-fuels/
[xxix] CBC News, 25 January 2016, LNG replacing diesel? Not for a long, long while, available from: http://www.cbc.ca/beta/news/business/lng-diesel-bison-shell-cnrail-2016-1.3414257
[xxx] Federal Railroad Administration, 19 November 2009, Comparative Evaluation of Rail and Truck Fuel Efficiency on Competitive Corridors (p.23), available from: https://www.fra.dot.gov/eLib/details/L04317
[xxxi] Ibid (p.4)
[xxxii] Ibid (p.81)

[xxxiii] Railway Association of Canada, 1 December 2015, Rail Trends 2015 (p.14), available from: http://www.railcan.ca/publications/trends
[xxxiv] Railway Association of Canada, 1 December 2015, Rail Trends database (tonnes per carload Class I rail)
[xxxv] Federal Highway Administration, 1 May 2003, Commercial Vehicle and Size Weight Program, available from: http://ops.fhwa.dot.gov/freight/sw/overview/index.htm
[xxxvi] Transport Canada, 29 July 2015, Annex to the Transportation in Canada Annual Report (p.93,94), available from: https://www.tc.gc.ca/eng/policy/anre-menu.htm
[xxxvii] Railway Association of Canada, 2013 LEM Report (p.12, p.18), available from: http://www.railcan.ca/publications/emissions
[xxxviii] Transport Canada, 29 July 2015, Annex to the Transportation in Canada Annual Report, (p.94), available from: https://www.tc.gc.ca/eng/policy/anre-menu.htm
[xxxix] Sawyer, D (2011). Greenhouse Gas Market 2011 (p.49). Geneva, Switzerland: International Emissions Trading Association.
[xl] Flemming, Brian, 20 May 2015, The political economy of Canada's transportation policies in 2015: the "what" is easy; the "how" is hard (p.9), available from: www.mun.ca/harriscentre/aptf2015/Brian_Flemming_presentation.pdf
[xli] Government of Ontario, 16, November 2015, Cap and Trade Program Design Options (slide 16), available from: https://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTI2NTI2&statusId=MTkwOTcw
[xlii] Government of Quebec, 22 February 2016, The Green Fund, available from: http://www.mddelcc.gouv.qc.ca/ministere/fonds-vert/index-en.htm
[xliii] Ministry of Transport, Sustainable Mobility and Transport Electrification, 22 February 2016, Programme visant la réduction ou l'évitement des émissions de gaz à effet de serre par le développement du transport intermodal , available from: https://www.mtq.gouv.qc.ca/partenairesprives/transportferroviairemaritimeaerien/programmes-aide/Pages/Programme-reduction-evitement-ges.aspx
[xliv] Government of Canada, 30 November, 2015, Canada's National Statement at COP 21, available from: http://pm.gc.ca/eng/news/2015/11/30/canadas-national-statement-cop21
[xlv] Government of Canada, 29 January 2016, Federal, provincial and territorial governments working together on first steps towards a pan-Canadian framework to address climate change, available from: http://news.gc.ca/web/article-en.do?nid=1030449
[xlvi] Government of Canada, 11 February 2016, Remarks for Catherine McKenna, Minister of Environment and Climate Change, available from: http://news.gc.ca/web/article-en.do?nid=1033379