Sustainable Rail: On Track

A Promising Outlook with Room for Improvement - Canada's Railways & the Low Carbon Transition

Analysts

Alex Meile
alex.meile@mail.utoronto.ca

Jonathan Rincon Lopez
jonathan.rinconlopez@mail.utoronto.ca

Jun Park
kjun.park@mail.utoronto.ca

Yazen Abed
yazen.abed@mail.utoronto.ca

Lab Director
Professor Mark Manger
mark.manger@utoronto.ca

Global Economic Policy Lab

munk school
OF GLOBAL AFFAIRS & PUBLIC POLICY

UNIVERSITY OF TORONTO

Rail Overview

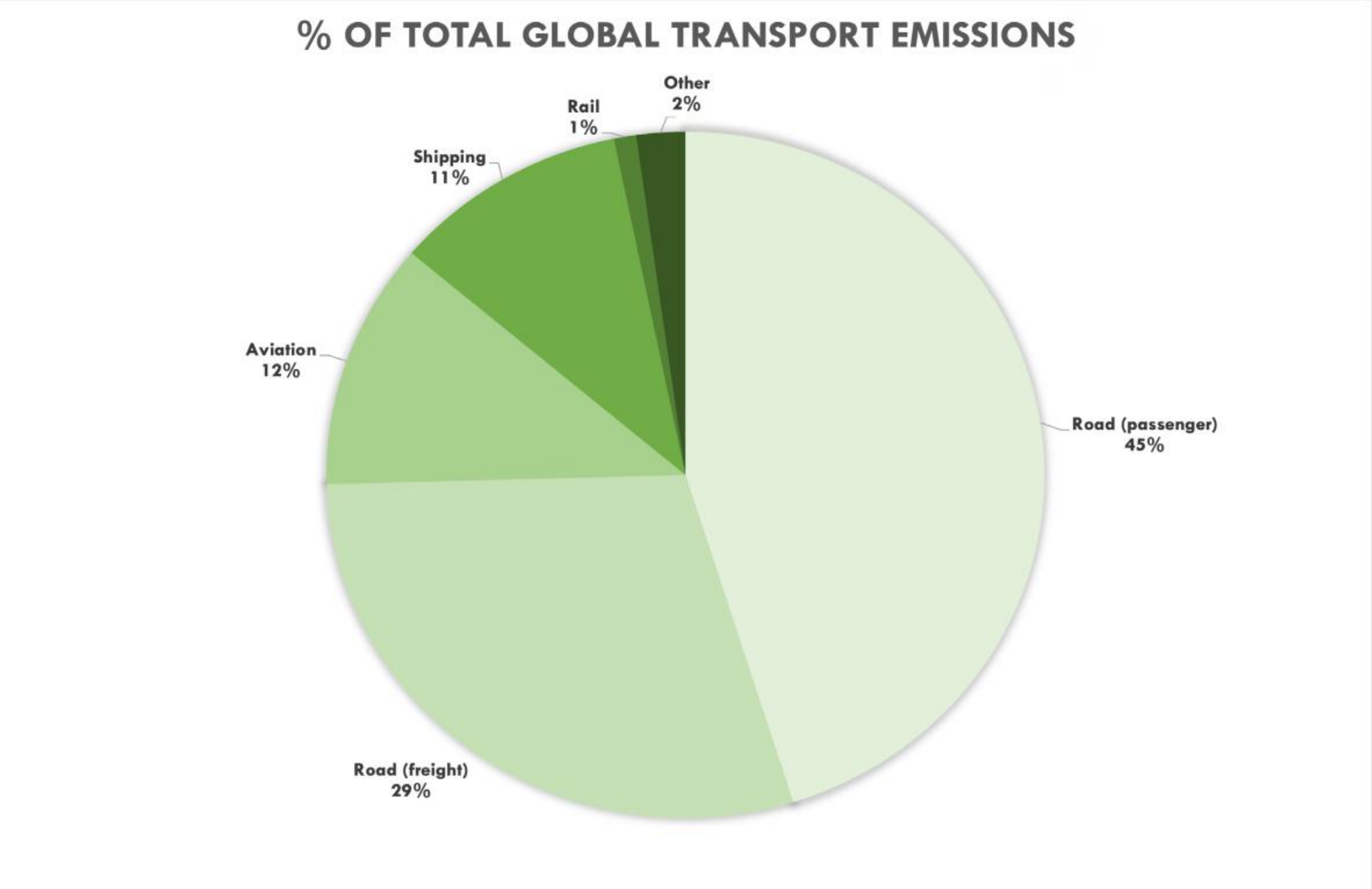
- The transportation sector remains key to the path towards a net-zero economy as it accounts for 26% of global greenhouse gas emissions.
- Rail transit is the lowest emitting source of transit with up to 12 times lower emissions per passenger-km compared to private vehicle emissions. As such, increasing the total share of rail transportation will be key in decarbonization of the sector.
- Increasing electrification, and high speed rail usage will move us closer to full decarbonization of transit.
- Currently, rail transit comprises 8% of global passenger transit - if we are to achieve a net-zero scenario, this figure needs to increase to 12%
- Europe and Asia are the two regions with the most rail usage - with some countries relying up to 90% on rail transit
- Passenger rail across Canada and in Ontario have made strides towards electrification, with major improvements set to be complete by 2030.
- Canada's rail-freight companies continue to account for a significant source of the transport sector's Greenhouse Gas Emissions - CP and CN are taking steps toward decarbonizing their operations.
- If Canada were to implement high speed rail (HSR) they could take the approach of South Korea and engage in a joint venture Investment into railroad infrastructure - including freight.
- Canada's rail-freight sector should continue to hedge its bets on hydrogen fuel cells for long haul freight operations and on biofuels for shunting operations.
- Following electrification of heavy trafficked passenger rail corridors, the focus for Canada should be on hydrogen fuel cells, and batteries for shorter distances. Digital applications will also play a role in driving long-term improvements in efficiency.

Rail Transit Towards Decarbonization

In October 2016, the 193 parties to the Paris Agreement collectively set a goal for the world to reach net-zero emissions by 2050, in order to keep anthropogenic global warming below 2 degrees Celsius (compared to pre-industrial levels). We now know that limiting global warming to these levels would mean reducing the stress on people and life on the planet from the more extreme effects of climate change. For example, the difference between limiting warming to 1.5 degrees vs. 2 degrees is a decrease of 50% in the people around the world who would experience water stress. While some climate change (including rising sea levels, increased frequency of droughts and floods, and increased heat-related human mortality among others) is now locked in due to our activities up until this point, as reported by the IPCC's 2022 AR6 report, there is also a closing window where we can still make a difference and stop the more extreme effects of climate change.

A big part of this effort needs to be targeted at the transportation sector worldwide, which in 2016, accounted for over 26% of global CO2 emissions, attributable to the fact that it is the most fossil fuel-reliant sector. The parties to the Paris Agreement have recognized the importance of this sector within their Nationally Determined Contributions (NDCs), with 80% of them noting that it is important in the transition, and at least 60% recording some form of mitigation measures for this sector. The biggest share of global transportation emissions is in the use of passenger road vehicles, accounting for almost 42% of total sectoral emissions in 2019 according to the International Energy Agency (IEA). It goes to reason that interchanging passenger road vehicle miles for public transportation where efficient would be a low-hanging fruit towards reducing the emissions intensity of transportation overall.

Some early studies done in the United States in 2008 found that cutting just one 32 km round-trip business day commute done by a single passenger in a road vehicle could lead to a "10% reduction in the carbon footprint of a two-adult, two-car household." Rail transportation intuitively offers a lower energy intensity for transporting both people and cargo on a per-unit basis. Overall, it requires "12 times less energy and emits 7 to 11 times less GHG emissions per passenger-km traveled" than is the case for private vehicles and airplanes, which actually makes it the most energy-efficient mode of motorized transport. It is, therefore, no surprise that it only accounted for about 1% of Transportation's share of global greenhouse gas emissions in 2018.



Source: Our World In Data

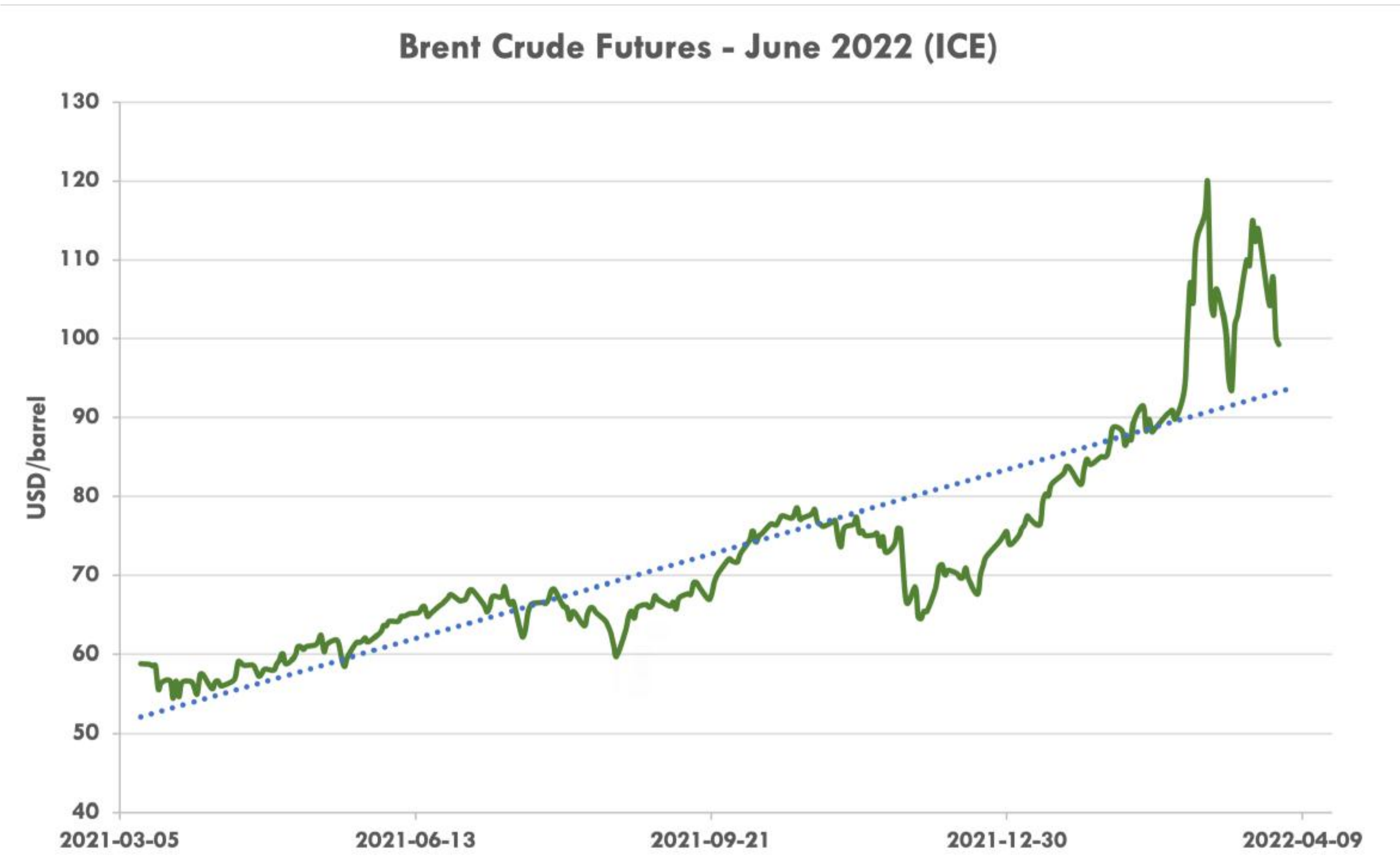
A clear pathway towards reducing operations emissions of road transport would then be to shift as much demand, both in terms of passengers and cargo, towards rails - thereby streamlining heavy flows of movement where it makes sense. In the IEA's Net-Zero scenario to 2050, this means increasing rail transport's share of total passenger transport activity from 8.5% in 2020 to 12.6% in 2030.

Rail is hailed as one of the most energy-efficient transport modes, it carries 9% of global passenger movement and 7% of freight, while only using 3% of transport energy usage. Rail, in fact, on average requires 12 times less energy compared to other modes of transportation along with emitting 7 to 11 times fewer greenhouse gasses (GHG) per passenger-km compared to vehicles or airplanes. The global average of emissions for rail transport is estimated to be 19g of CO2/ passenger-km, compared to small and medium cars with an average of 148g of CO2/ passenger-km and airplanes with an average of 123g of CO2/ passenger-km; demonstrating the efficiency of rail transport.

While rail is already amongst the lowest carbon-emitting methods of transport, oil accounted for 55% of total energy consumption for rail and was used for 28% of all passenger rail activity. However, this figure is expected to rapidly change as much of the new rail infrastructure being built globally is electrified. It is estimated that ¾ of all passenger rail activity is electrified, a 60% increase since 2000. Some regions are almost completely electrified with 97% of all rails in Japan being electrified, with Korea clocking in at 90%. While Asian and European countries have the most electrified rail systems, North America by far has the most extensive conventional rail network, with over 612,000 km of rail in service today, compared to Europe where it only has 328,000 km. Compared to some Asian and European countries, North America is lagging in terms of electrifying its rail infrastructure; however, it also presents immense potential for the continent as rail can be the catalyst for transforming the continent's infrastructure to become more sustainable and contribute toward the low carbon transition strategy.

Fossil Fuel Prices

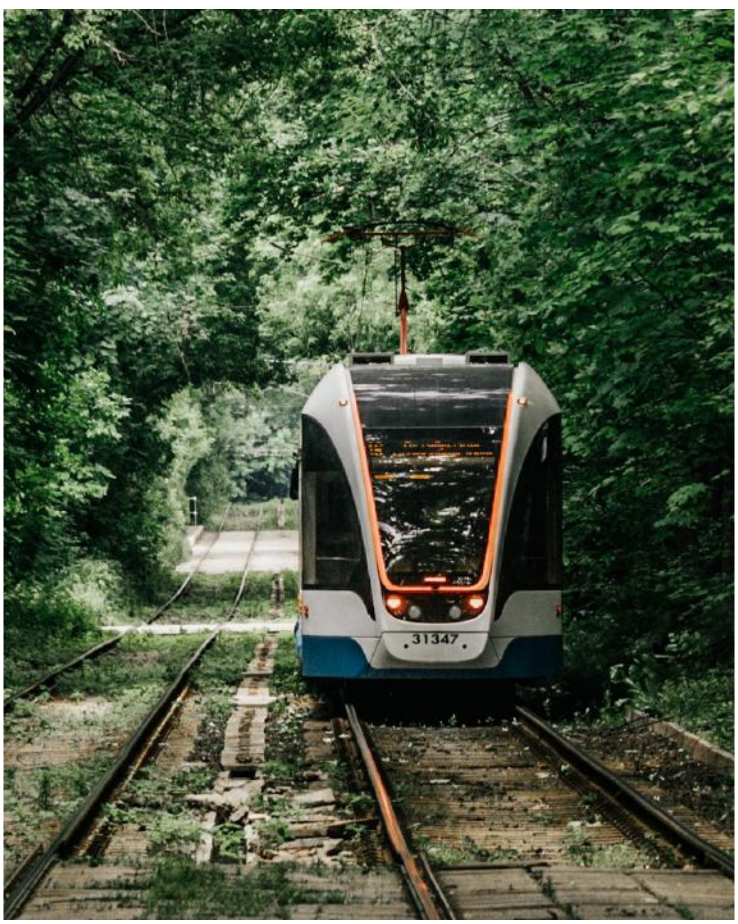
Apart from climate impact, the recent surge in oil prices, and in turn gasoline, is also forming grounds for a sound economic argument for transitioning road transport to rail transport wherever possible. Earlier this year, our group covering the Low-Carbon Transition at the Munk School's Global Economic Policy Lab (GEPL), covered the incredible 2021 400%+ rally in European natural gas futures as a response to COVID-19 demand and supply reshuffling. This was before the Russian invasion of Ukraine in late February 2022, which has seen the price of crude oil increase by about 24% since then to levels above $100/barrel - which we had not seen since 2014. A similar story can be seen in the price of gas as tracked by Dutch TTF futures - following news of the Russian invasion, the price quickly spiked to higher prices than were seen at the end of 2021 and has since settled to just above 100 €/MWh.



Source: Bloomberg

The globally coordinated economic sanctions imposed on Russia as a response to their invasion are also laying bare the necessity to wean off fossil fuel imports and work towards energy independence in Europe (which still imports about a 1/3 of their natural gas from Russia). Both supply-chain entanglements resulting from COVID-19 lockdowns and the Russian invasion have sent the price of gasoline skyrocketing across the world. In Canada, the commodity has seen a 143% increase since a low point in April of 2020 to the highest levels ever seen (current price: US $1.27 per liter).

This price shock has sent signals to consumers of the need to rethink the way they get around. When comparing the operational costs of electric vehicles per 100 km with similar internal combustion models, the costs of the former are currently 77% lower on average than the latter across all Canadian provinces at the current electricity and gasoline prices. Naturally, consumers currently unable to switch to electric vehicles are shifting more of their commuting towards public transportation, including rail where applicable, which would still lower their overall carbon footprint inadvertently. In addition to shifting demand from road vehicle transportation, the electrification of railways, in combination with a higher share of renewable energy in electricity generation offers almost a certain progression towards net-zero in-land transportation.



Rail Eletrification

Globally, electric railways represent approximately 37% of the total, with this trend increasing in the past two decades as renewable energy sources bring down the overall cost of electricity worldwide. In contrast, the United States' (US) freight rail system is nearly powered entirely by diesel and accounts for almost half of global emissions in freight moved on rails. A similar story can be told for Canada, where only 80 km of 49,500 (0.16%) are electrified, while only approximately 20% of Europe's rail system runs on diesel.

This is still the case today despite the fact that electrified rail transport offers a number of well-known advantages over diesel-powered rail which include: reduction in noise and air pollution, lower emissions, and overall higher fuel efficiency. Recent innovations such as regenerative braking, advances in hydrogen fuel cells, increases in battery densities, and the continuing reduction of electricity prices as renewable energy is rolled out, are promoting the wide adoption of the superior electric rail system. Such innovations and policies toward increasing the electrification of rail are further explored in Section 3 of this research note.

High Speed Rail

In recent years, the implementation of high-speed rail infrastructure has proliferated across the world, especially in China, where the country added 41,000 km of high-speed tracks since 2005. High-speed rail is characterized by rail services over a long distance with speeds exceeding 250 kmph. High-speed rail is particularly impactful in high-density, high-traffic areas as it serves as an alternative to short regional flights. As such, high-speed rail has been particularly popular in European countries along with Japan and most recently China. While certain corridors in North America such as the Seattle to San Diego corridor, the Boston to Washington corridor in the US, and the Windsor to Montreal corridor in Canada could be potential locations where high-speed rail could make a significant impact in terms of reducing reliance on cars or flying.

While high-speed rail provides tangible transport benefits, it has various social benefits as well. Namely, the implementation of high-speed rail creates jobs; it is expected that for every billion dollars spent it creates roughly 24,000 jobs. Another more immediate benefit is an increase in productivity. It is estimated that in the US congestion costs $140 billion in lost time and productivity. With the US population expected to grow by another 100 million people in the next 40 years, it is expected to create mega-regions with cities exceeding populations of +10 million, current road infrastructure will be insufficient and other methods of transportation will be needed. High-speed rail networks, with their ability to transport large quantities of people with relatively high frequency, are one of the best options to help relieve congestion and improve mobility between high-density regions and cities.

Despite all the tangible benefits of high-speed rail systems, there are currently none operational in either the US or Canada. There are a couple of reasons for the absence of high-speed rail in North America, some of the prominent reasons include associated costs along with lower population densities compared to Asian and European cities. While North America has numerous large cities, these cities tend to be more distant compared to cities in Europe or Asia. Another factor includes the associated costs required to build these infrastructures. Before being scrapped, Ontario had plans to build a high-speed rail network stretching from Windsor to Toronto. The total length of the network would be 350 km and cost $55 million per km, costing a total of $19 billion for the entire project. Due to its high costs, the project has been put on hold by the Ford government citing funds could be better allocated. While the project's future is uncertain, given that Ontario's population is expected to increase by over 5 million people in the next 26 years, a high-speed rail network could provide much-needed transit options along with a tool for economic growth in the province.

Sustainable Fuels

Another option being explored towards advancing the sustainability of rail transportation is alternative fuels. While this realm is not as advanced nor understood as the electrification of rail, it offers a promising alternative to fossil fuels and the last 10% of the system that is hardest to decarbonize. Potential alternative fuels for this end include Liquid Natural Gas (LNG) with Carbon Capture and Storage technology (CCS), Hydrogen, and Biodiesel. Of this whole bunch, biodiesel has gotten the most attention with trials occurring in Europe - utilizing B20 blends (blending 20% biodiesel with regular diesel) and in Canada.

Because there has been relatively little progress in this area, the body of this research note will focus on best practices towards electrification, as well as efficiency and adoption of rail systems.

This overall aim will be to forecast an outlook for Canada's rail systems in the short-term, medium-term, and in long-term. The following section will cover the current status of rail transportation in Canada, with the one after that introducing best practices towards both increasing shares of rail transportation, and decarbonizing rail overall. We close with our Outlook for Canada both in the short-term (1-5 years) and medium-term (5-10 years).

Canada's Current Rail Landscape

Passenger

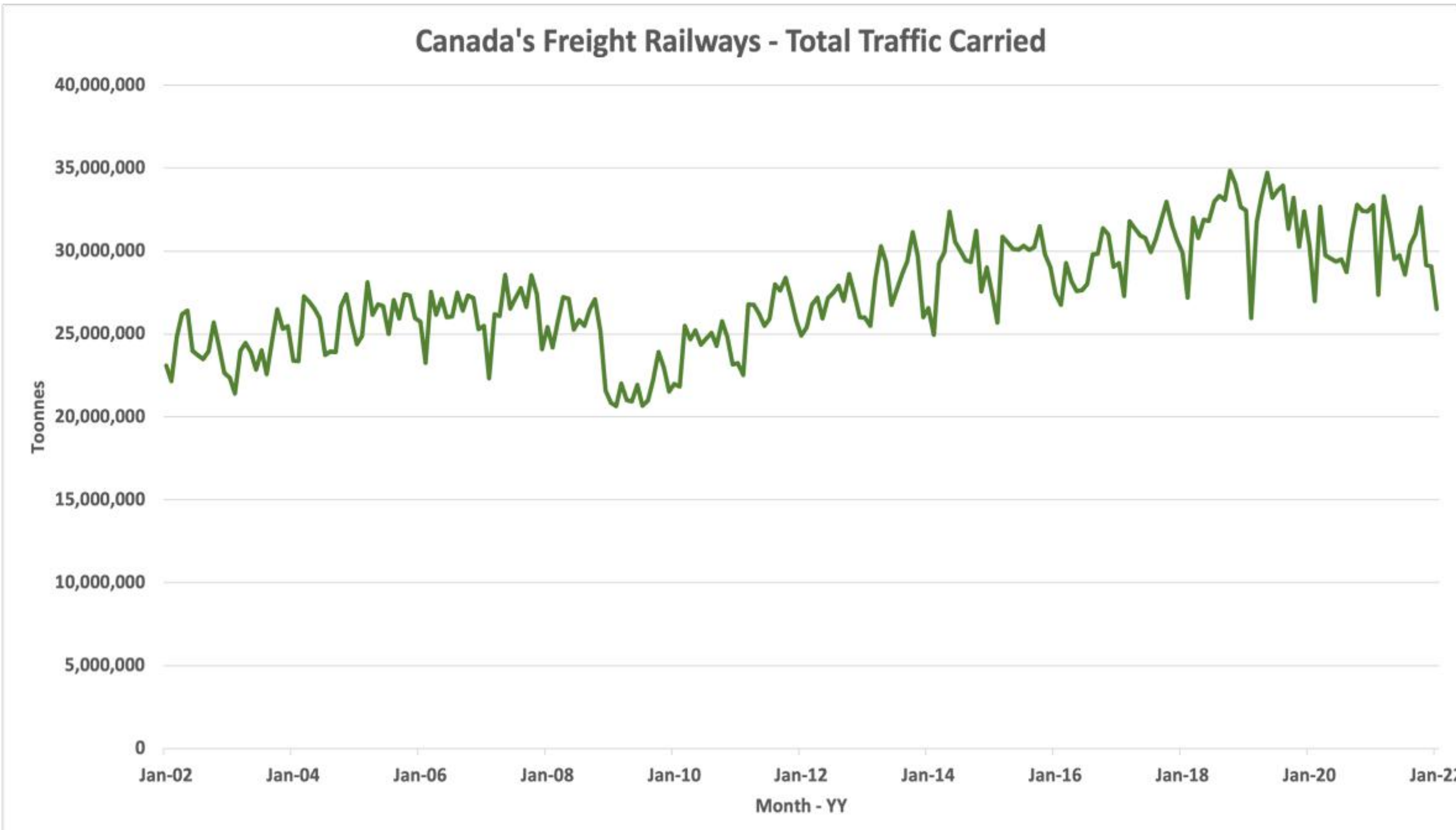
Canada remains heavily reliant on rail transportation for its commuting needs, with more attention being paid to major cities across the country such as Toronto. In Ontario in particular, transportation remains the largest carbon emission source, as 33% of all emissions are a result of pollution produced by cars, buses, and passenger rail. Despite the rail transport industry generating roughly $10 billion a year in revenue, only about 5% of that is a result of commuter, intercity, and passenger rail services. While generating only 5% of the revenue, commuter rail services remain costly to maintain and only yield small returns of revenue. The Toronto Transit Commission (TTC), the largest transit system in Canada, is estimated to be the costliest transit system per fare in North America while not receiving provincial or federal subsidies. In fact, TTC subways are electric-powered and mostly run on nuclear and hydropower, which make them environmentally friendly. On average, the amount of CO2 emissions produced by a TTC subway ride compared to a car trip for the same distance is nearly 80 times less. However, with limited funding and rising costs amidst a net loss of $700M during the COVID-19 pandemic in 2020, the TTC has been unable to provide an efficient service, leading more people to drive cars and emitting more CO2 per day.

For those who commute to Toronto from surrounding towns in the Greater Toronto Area (GTA), GO Transit is one of the preferred options. Currently, all GO trains are operated by diesel locomotives. It is estimated that the GO train carries roughly 200,000 passengers on about 180 train trips per day each week, accounting for a carbon emission per passenger per km of 74 grams, compared to around 54 grams/km for electric locomotives. Electrifying GO trains would reduce their carbon emissions by 94%, which compounded by the fact that the source of Ontario's electricity largely comes from renewable or low carbon sources, would significantly decrease Ontario's carbon footprint.

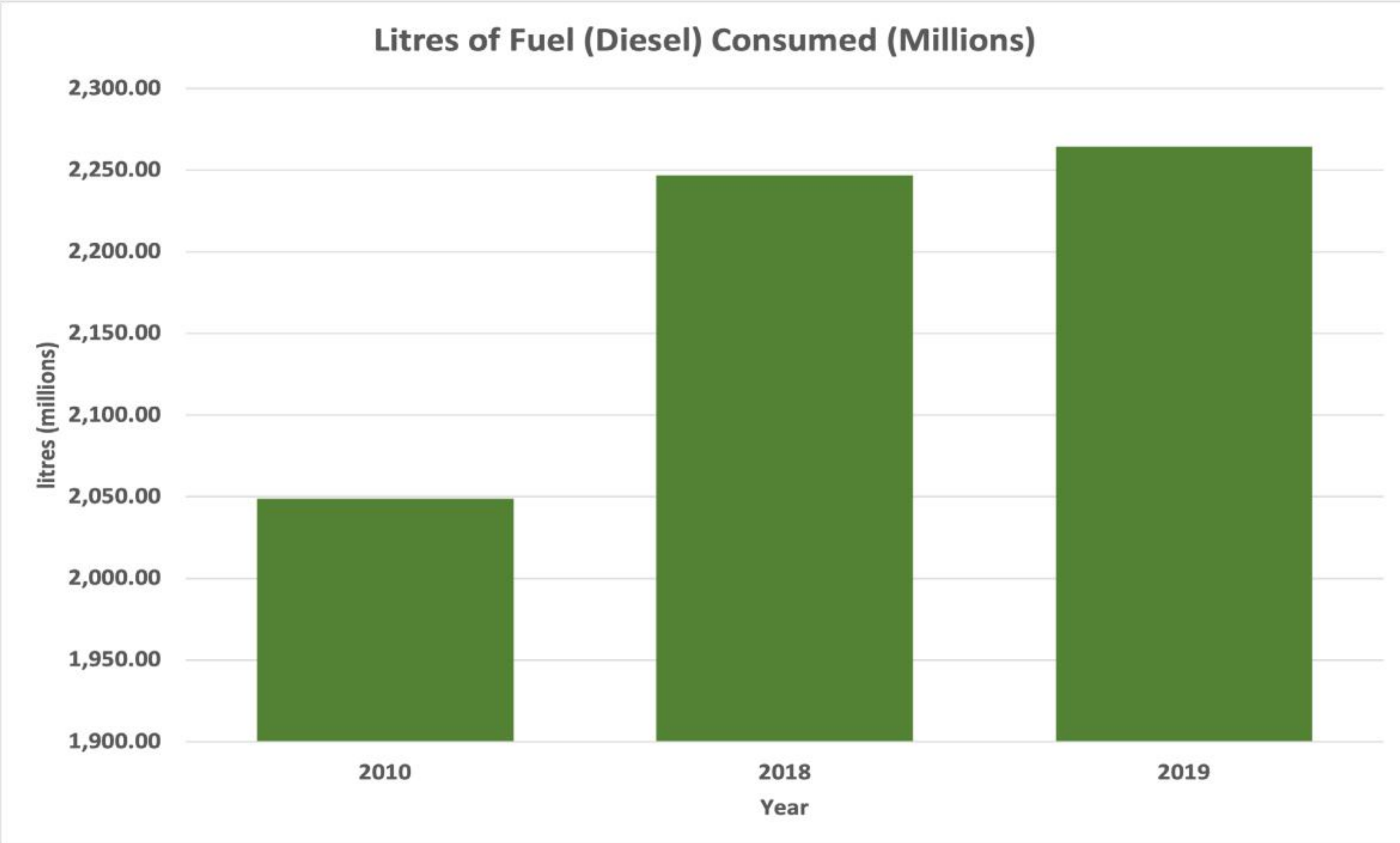
VIA Rail, the largest regional transportation service in Canada, has taken great strides to become more eco-friendly in recent years. Studies have shown that despite its reputation as a cleaner alternative, VIA Rail has been shown to emit a higher carbon footprint per passenger than air travel. This has not deterred VIA Rail, which has claimed to have reduced 289,177 tonnes of CO2 in 2019 compared to car travel and on average, uses 4x less energy than cars. To further illustrate this reduction, VIA Rail used various initiatives to see a 37% reduction in Scope 1 and 2 GreenHouse Gas (GHG) emissions compared to 2005. Having green objectives that align with the United Nations Global Compact (UNGC), VIA Rail has the objective to have 75% of new vehicle purchases be zero-emission vehicles with the ultimate goal of a fleet of 80% green vehicles by 2030.

Freight

The Canadian freight rail scene is dominated by the Canadian National Railway (CN) and the Canadian Pacific Railway (CP), which are both Class I railways that account for 95% of the total $10 billion generated by the total rail industry in the country. Together, CN and CP account for 95% of Canada's annual rain tonne-kilometers on ~46,000 km of tracks, of which they collectively own 75%. Nearly 70% of intercity surface goods, including 40% of Canada's total exports, are carried by these two rail-freight giants. Jointly, 332 million tonnes of freight were hauled by CP and CN in 2019, which translated to $205 billion delivered in export goods, and that for an effective cost of 3.5 cents for one tonne/km (see graph below). With these figures in mind, it is evident that both firms operate a large and capital-intensive business, which almost entirely rests on the use of diesel engine locomotives. Consequently, the current carbon footprints of CN and CP leave much to be desired for. In 2019, the two freight railways in Canada consumed a total of 486 million gallons (2.1 billion liters) of diesel fuel, whilst simultaneously the sector's overall fuel efficiency has been decreasing slightly from 669 revenue tonne-miles (RTM) to 667.1 RTM (see graph below). However, in the broader context, it must be noted that the overall rolling stock in service for both firms increased - by 2.9% for freight cars and 1.4% for locomotives. Simultaneously, intercity rail freight produced only roughly 2.5% of Canada's total transportation sector greenhouse gas (GHG) emission, as one locomotive can haul one tonne of goods for more than 210 km on one liter of diesel, which equates to removing up to 300 trucks from the roads for that distance.



Source: Stats Can



Source: RailCan

Despite freight–rail's relatively little contribution towards GHG emitted by Canada's transport sector, CN and CP are committed to working towards Canada's net-zero emission strategy for 2050. Both operators have so far taken steps to decarbonize their operations and reduce overall emissions through investments in low carbon technology. CP for one will introduce its hydrogen-powered locomotive prototype H2-OEL in Alberta by the end of 2022. CP is hedging its bet on a cost-effective approach by retrofitting existing diesel-electric line-haul locomotives with a hydrogen fuel cell and battery technology to power the unit's electric traction motors. Three of these prototypes will hit the rails by the end of the year. The project is supported by a $15 million grant from Emissions Reduction Alberta, which will entail the installation of various hydrogen production and fueling facilities along with two CP rail ards in Alberta. If the concept proves successful, these hydrogen-powered locomotives have the potential to drastically reduce rail-freight emissions - this does, however, depend on the type of hydrogen use i.e. blue, green, purple, or grey.

Whilst CN is also taking steps in a similar direction, these mainly impact its U.S. business segment, and will thus not be elaborated on at length. As opposed to CP's hydrogen ambitions, CN hedges its bets on new factory line FLXdrive battery-electric locomotives from U.S. producer Wabtec. These are to be deployed in the near future on U.S. network segments. Whilst this approach is a step in the right direction, these new locomotives come with one flaw - they need to be deployed in tandem with another diesel locomotive to guarantee the functioning of essential systems. Yet they'll still be able to reduce emissions by ~30% per train. As such, CN is applying a broader scope approach by attempting to curb emissions through retrofitting rolling stock with fuel-saving technology, which includes the use of big data, as well as introducing electric trucks to move freight from railyards to urban areas.

High Speed Rail Implementation

Developing a domestic HSR system is a costly and time-consuming endeavor. Countries like Japan, Germany, France, and China have been able to develop domestic HSR systems which have been widely successful. More and more countries have demonstrated interest in HSR; however, many countries lack the knowledge and skillsets required to implement such systems and therefore have partnered with prominent HSR manufacturers. An example is South Korea, where the government partnered with the French company Alstom to help build HSR in the country. The project started in 1994 with the objective to connect the country's two largest cities of Seoul and Busan, in anticipation of fostering balanced land development as the fluid movement of people from the two cities would promote economic growth and help grow under-developed regions. Another objective of this joint venture was to acquire technology transfers from Alstom to develop new industries in the country as it was seen to improve the country's technological capabilities and draw foreign investments. On the other hand, Alstom saw this opportunity to demonstrate the exportability of their technologies along with using it as a bridgehead to gain further clients in Asia.

The project was estimated to cost $9 billion at the time, with Alstom providing $2.4 billion to help fund the project. The deal between the Korean government and Alstom consisted of a 100% technology transfer of Alstom's TGV technology to 15 Korean firms involved in the project along with the construction of half of the trains in Korea. In addition to the technology transfer, Alstom was responsible for other crucial components of the project including the management of rolling stock (trains), catenary systems, signaling, maintenance and training, and project management and system integration. There were concerns when the deal was inked as it could create a boomerang effect which is the risk of creating new competitors in the acquirer of the new technology in the case of technology transfers. The boomerang effect was particularly concerning in Korea as labor costs were cheap in conjunction with the country's reputation for having lax copyright laws at the time. To mitigate this, Alstom has continued working with the Korean government aiding in future train developments along with forging various deals with Korean manufacturers in addition to continuing their robust R&D to maintain their competitive edge. The project has encountered various issues during its lifespan with engineering challenges and constant political pressure from a newly elected government in 1997 that was explicitly against the HSR program. The set of delays and political pressures resulted in contract renegotiations and cutbacks from the original plan; despite these setbacks, however, the project was completed in 2004, with the final cost reaching $18 billion in 2004 ($34 billion in 2022).

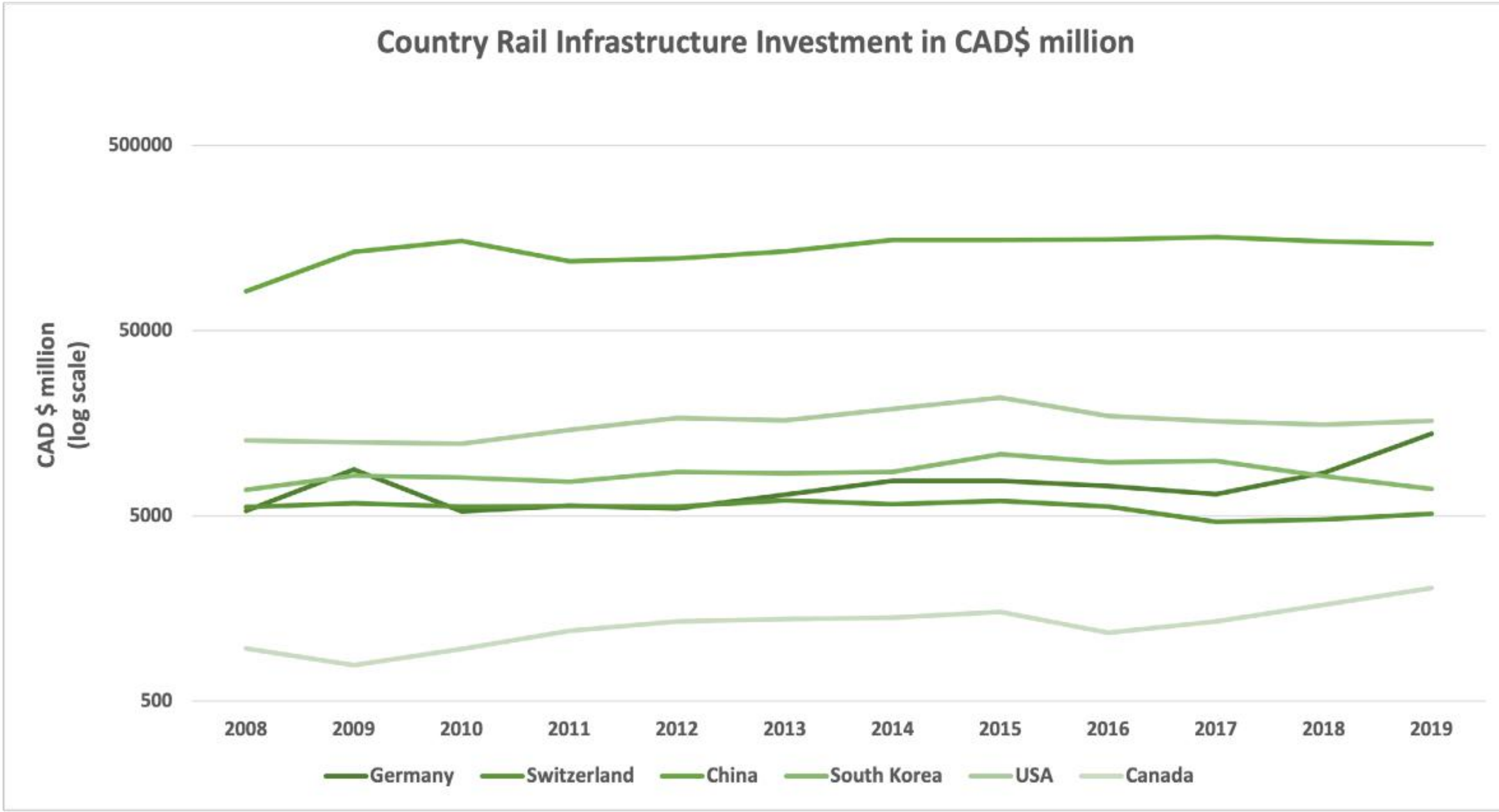
The project was eventually completed in 2004 with the first set of Korean High-Speed Trains (KTX) traveling a 412 km route from Seoul to Busan. Since its inception in 2004, the KTX system has grown substantially, by 2017 the system was extended to 596 km with daily ridership increasing from 72,000 to 162,000; at the end of 2016, the total cumulative ridership for the KTX reached 586 million, from a population of roughly 50 million people. Additionally, the technology transfers from Alstom have aided in the development and production of Korea's first domestic HSR, the KTX Sancheon which has been in operation since 2010 and can reach speeds of 305 km/h. The expansion of the HSR services has generated positive environmental impacts, for example, the route between Seoul and Busan in the first four years of operation increased its market share from 40% to 65% and airlines' share of the same route decreased from 42% to 17% - reducing greenhouse gas emissions from potential air travel.

The partnership between Alstom and Korea has been a success, with Korea reaping various benefits from the deal such as the creation of new industries, international business experience, technological development, and creation of high skilled jobs to name a few. On the other hand, Alstom has reaped several benefits from the deal including cash payments and royalties for access to its technologies, dividends from joint ventures in Korea, development of technical experience and know-how in the Korean market, which can be utilized in other Asian markets, and the creation of new business ventures and opportunities to name a few.

The partnership can be seen as a strategy for governments that are seeking to implement HSR. While the partnership will likely have some challenges, the end benefit of a successful project has the potential to offset much of the costs associated with serving as an economic multiplier.

Freight - Hydrogen Fuel Cells & Biofuels

Whilst there are noticeable improvements underway in Canada's rail-freight sector to decarbonize operations, the industry could potentially look at other global innovative rail-freight efforts towards a net-zero future, gaining insights that can be analyzed in the Canadian context. The global rail-freight markets - i.e. in Europe, North America, and Asia - vary greatly in terms of their existing infrastructure, annual investment levels, and the demand structure for goods transported on rail. One noticeable difference here is that Europe runs the largest electrified rail-freight system in the world, yet China's significant investments in recent years into railroad infrastructure are closing this gap. In other words, Canada finds itself lagging behind Europe and Asia both in terms of electrification levels and most notably in overall rail infrastructure investments. Despite an all-time high investment level of $3.1 billion into Canadian railway capital programs in 2019, Canada continues to perform poorly in comparison to most notably China, the U.S., and Germany (see Graph below). Closing this gap, however, costs immense sums of money, which is not necessarily what the Canadian rail-freight landscape requires in order to move towards low-carbon emissions.



Source: CEIC

Europe's extensive electrified railway system constitutes a noteworthy achievement as it offers countries on the continent to ship freight on a largely carbon-neutral rail network. The Rhine-Alpine corridor - a joint rail-freight project between the governments and railways of the Netherlands, Germany, Switzerland, and Italy - has been paving the way for carbon neutrality for rail cargo as it connects the port cities of Rotterdam and Genoa. Aside from the shunting yards, this corridor connects four countries with a ~3,000 km electrified rail network. Canada could in principle strive to attain a similar corridor on high-frequency rail-freight routes out west, with Canada's comparative advantage being that CP and CN own the majority of the country's tracks, meaning freight operators have largely free reign as opposed to their European counterparts. Whilst the United Kingdom (UK) is hedging its bets on fully electrifying its rail network by

2040 through new innovative capital investments, which is to include shunting yards, Germany is seeking a cost-effective approach of substituting diesel with biofuels on its non-electrified segments. Given the nature of Canada's rail-freight sector - in terms of geographic span and current investments into low carbon operations - it makes little sense to push electrification on Canada's rail-freight network. Instead, emphasis should be placed on CP's current approach to introducing hydrogen-powered freight trains. CP's approach does seem to offer a more promising solution to achieving the 2050 net-zero emission targets in a cost-effective manner. Considering that battery-powered locomotives require to run in tandem with diesel units, CP's hydrogen fuel-cell powered trains seem to offer a more immediate impact in reducing the industry's GHG emissions in Canada. The construction of a Calgary facility with electrolysis plants running on solar power is already well underway. Similarly, CP has begun building up a blue hydrogen facility in Edmonton. CP's efforts in retrofitting its rolling stock and facilities towards hydrogen operations will in part be supported by Vancouver-based Ballard Power Systems, which provides CP with 14 200Kw fuel cell modules for their locomotives. Despite costs remaining the main hurdle in scaling up this hydrogen fuel cell technology - as one 200Kw fuel cell costs ~$200,000 and remains labor-intensive in its production process - the future potential for emission-free rail-freight is certainly greater with CP's hydrogen-based approach. As opposed to CN's efforts to reduce emissions through a combination of battery-powered trains and data-driven solutions aimed at reducing emissions of diesel locomotives, the hydrogen approach offers a more impactful opportunity for contributing to the low carbon transition. Concerning shunt yard operations, CP and CN rail could seek to mimic the efforts of Deutsche Bahn Cargo, by switching their shunting locomotives to biofuels (Hydrotreated Vegetable Oils - HVO). This approach does not require vast sums of investments, as existing fleet locomotives can simply be retrofitted towards biofuels that are free from palm oil, thus resulting in lower overall operations emissions from end-to-end.

Outlook for Canada

Short Term (<5 Years)

Freight

Within the next five years, the Canadian freight-rail sector will begin a gradual transition into decarbonizing its operational structure and commit to alternative fuel sources for its rolling stock. CP will be bringing three converted diesel locomotives on track by the end of 2022 that will now be powered by hydrogen fuel cells. CN meanwhile will introduce a battery-powered locomotive, yet on its US network, which is thus not impacting emissions within Canada. However, CN does seek to scale back its Scope 1&2 emissions by 6% by the end of 2022. Therefore, CP's steps towards scaling up its hydrogen-powered fleet and facilities in western Canada - i.e. Alberta - will constitute the first serious steps toward decarbonizing the Canadian freight-rail system.

Passenger Travel

The short term developments in passenger rail travel have already been set in motion by the country's biggest players in this space:

- Metrolinx, the Crown company of the Government of Ontario that manages GO Transit, recently announced plans for electrifying the entire GO train network, although costs for electrification can amount to nearly $4 billion. Although electrifying the current GO train infrastructure comes with its environmental benefits, travelers commuting by car to the nearest GO station puts a cap on Ontario reaping the full opportunity cost of electrification.
- When it comes to cross country travel, VIA Rail has proposed the establishment of a High-Frequency Rail, which would be a fully electric rail network between major cities (Québec City-Montréal-Ottawa-Toronto) in 2030 that would see current infrastructure upgraded along newly built tracks, separating passenger and freight trains and contributing to further reduction of GHG emissions. This project, which Minister of Transport Omar Alghabra had previously pegged to cost between $6 and $12 billion, has recently called for expressions of interest from companies in the private sector who will prioritize both the environment and indigenous communities. Despite concerns about ownership of the project, the High-Frequency Rail seeks to become a new efficient, and sustainable mode of transportation across Canada
- Subway expansions in major cities will continue at a slower pace. The TTC has begun planning its "Ontario Line", a 16 km line servicing 15 stops from Exhibition Place in the southwest of Toronto all the way up to the Ontario Science Centre in the northeast of the city. This line would conceivably reduce traffic on Line 1, provide multiple connections to streetcars, and projects to reduce cars on the road by 28,000 and reduce 7.2 million liters of fuel consumption by providing a quick and easy alternative. In February 2022, Metrolinx released their draft Environmental Impact Assessment Report, requesting public feedback on ways to ensure environmental and community harmony. The project is set to be complete by 2030.

Medium Term (5-10+ Years)

Freight

Over the next 5-10 years and by 2030 both Canadian freight-rail operators seek to have made significant steps towards achieving a notable curtailment of their GHG emissions. By 2030, CN aims to reduce its Scope 1&2 emissions by 43%, whilst curtailing its Scope 3 emissions by a notable 40%. They seek to achieve this through a science-based target approach, focusing on fleet renewals, optimizing the internal use of data, and promoting best practices on fuel conservation. Meanwhile, CP focuses on the 2030 horizon by scaling up the market readiness of renewable fuels - i.e. hydrogen - in order to decarbonize its freight rail operations and align its climate ambitions with IPCC recommendations.

Passenger Travel

In the longer term, as Canada aims to move towards the overarching goal of a 40-45% reduction in greenhouse gas emissions (from 2005 levels) by 2030, the focus will be on quickly moving towards the electrification of all rail corridors. As we've mentioned in the section above, the focus will first be on the heavily trafficked routes between major cities, and on regional networks like that of GO Transit's in the GTA.

Where electrification is not economically viable mainly because of lower loads, the focus should be on partially-electrified tracks along with hydrogen fuel cells, battery power, and charging points. Similarly, as rail is so much more energy-efficient and significantly less carbon-intensive than other forms of transport; especially with an electricity grid powered mostly by renewable energy as is the case for Canada, shifting a lot of automobile transportation towards electric rail will mean a large expansion of subway systems. This can be funded through redirecting carbon taxes, road congestion charges, and tolls towards the expansion of subway systems - thereby both disincentivizing automobile transport and funding expansion simultaneously. Similarly, Canada's new green bonds should be partly utilized towards this same goal.

The last angle to mention here is the adoption of digital technologies, and big data towards integrated planning of expansions, improving rail efficiency, and better-incorporating rail with other modes of transportation in cities. All of the above measures combined should move Canada closer to a fully green rail network and the ultimate goal of a net-zero economy.