BC-SMART Low Carbon Fuels Consortium

Decarbonising Long-Distance Transport

Newsletter Issue 6, May 2022

From the BC-SMART Secretariat

The BC-SMART Low Carbon Fuels Consortium (BC SMART) was established in 2019 with the goal of facilitating the decarbonisation of the long-distance transport sector. The consortium will achieve this goal by encouraging the production and use of low carbon-intensive transport fuels, via the collective actions of the "coalition-of-the-willing". The coalition includes stakeholders from industry, government and the R&D community with BC-SMART acting as a "dating agency"! In this way, BC-SMART will help the Province meet its CleanBC goals by reducing BC and Canada's transportation-related greenhouse gases (GHG's), while creating synergies between the many players needed to meet the Provinces ambitious, decarbonisation targets.

On 29th March, 2022 Prime Minister, Justin Trudeau announced the release of the 2030 Emissions Reduction Plan: Canada's Next Steps for Clean Air and a Strong Economy. The plan describes an ambitious, but achievable, sector-by-sector description of how Canada can reach its climate target of cutting emissions by 40% below 2005 levels by 2030. This will put the country on track to achieve a goal of net-zero emissions by 2050. The 2030 Emissions Reduction Plan includes $9.1 billion in new investments that will be used to cut pollution and grow the economy. The 8-point plan includes: i) Making it easier for Canadians to switch to electric vehicles; ii) Greening Canada's homes and buildings; iii) Helping industries to adopt clean technology and transition to net-zero emissions; iv) Making the Canadian grid even cleaner; v) Reducing oil and gas emissions; vi) Supporting farmers in building a clean and prosperous future; vii) Empowering communities to take climate action and, viii) Embracing the power of nature to fight climate change (Source: https://pm.gc.ca).

Aligned with the federal government, BC is committed to reducing greenhouse gas emissions by 16% below 2007 levels by 2025, 40% by 2030 and 60% by 2040. The CleanBC plan is British Columbia's way to develop a cleaner, better, low-carbon economy that creates opportunities for all. The CleanBC Roadmap describes how these actions will help the Province meet its climate goals and put B.C. on the path towards net zero emissions by 2050 (Source: www2.gov.bc.ca). In part, responding to policies such as BC's Low Carbon Fuels Standard (LCFS), oil-company Parkland recently announced a $600-million investment in building British Columbia's largest renewable diesel complex. The environmental impact of the renewable fuels produced by the refinery is equivalent to the permanent removal of approximately 700,000 or 25% of the passenger vehicles on British Columbia's roads (Source: www.parkland.ca).

One of the strengths of the BC-SMART consortium is to maximise the synergies between both the low-carbon intensive (CI) fuel producers and long-distance-transport users. As described in more detail in this newsletter, although Rail is one of the most energy-efficient and least carbon-intensive modes of long-distance transport, considerable progress is being made in reducing the CI of this component of the long-distance sector

Supported by:

BC Bioenergy Network
PARTNERING FOR A GREENER FUTURE

BRITISH COLUMBIA
Ministry of Energy, Mines and Low Carbon Innovation

Summary of BC-SMART activities since the last newsletter (Issue 5, February 2022)

- **Report**: Progress in Commercialization of Biojet/Sustainable Aviation Fuels (SAF): Technologies, potential and challenges (jointly with IEA Bioenergy Task 39)
- **Report**: Recent progress in the production of low carbon intensive drop-in fuels- Standalone production and co-processing (jointly with IEA Bioenergy Task 39)
- **Report**: Implementation Agendas: Compare-and-Contrast Transport Biofuels Policies (jointly with IEA Bioenergy Task 39)
- **Report**: "The potential to decarbonise rail using low-carbon intensive fuels, particularly drop-in biofuels", First draft completed, March 2022.
- **Joint BC-SMART/Task 39 webinar** on "Decarbonizing the rail sector via the use of low carbon-intensive fuels", May 12, 2022.

To access to the reports, please contact the BC SMART Secretariat.

The lead article in this issue of the newsletter provides a summary and the main takeaway messages of the recent BC-SMART/IEA Bioenergy Task 39 webinar. The webinar was a well-attended with 174 registrants from many regions of the world. The webinar mainly focused on how rail might be decarbonised by the use of low carbon-intensive fuels. The world-class panel was moderated by Dave Schick from the Canadian Fuels Association: (www.canadianfuels.ca/) and the speakers, presentations and a summary of the webinar are provided below.

Upcoming BC SMART Activities/Events

Next week, BC-SMART will host a Biojet/SAF workshop with our colleagues at C-SAF (https://c-saf.ca/). The workshop will update progress in how Canada might enhance the decarbonisation of the aviation sector. Further details about the workshop can be accessed at the BC-SMART website (www.bc-smart.ca/aviation/).

The BC Bioenergy Network (BCBN) has invited members of the BC-SMART secretariat, Drs. Mahmood Ebadian and Mohsen Mandegari to update the Guild on progress in "Decarbonizing the Canadian Rail Sector. There will be a focus on bio/renewable diesel, describing the opportunities and challenges of this approach. Further details about this event and registration can be found here.

As always, we appreciate your readership and value your input and feedback. Please email us your ideas or suggestions on how we can enhance the value of the BC-SMART newsletter. Readers are encouraged to send us any updates on decarbonising transport.

Thank you for reading and participating in the BC-SMART network!

Mohsen, Mahmood, and Jack

Some of the current BC SMART Consortium members

Decarbonizing the rail sector via the use of low carbon-intensive fuels

The global rail sector transports 7% of the freight and 8% of the world's motorised passenger movements while consuming only 2% of the energy used by the transport sector. Consequently, it is responsible for only 0.3% of the direct CO_2 emissions derived from fossil fuel combustion. Rail is one of the most energy-efficient and least carbon-intensive transport modes (Figure 1) and, on average, requires 12 times less energy and emits 7-11 times less GHGs per passenger-km travelled than private vehicles and airplanes. This makes it one of the most efficient modes of motorised passenger transport (Figure 1). As well as shipping, freight rail is one of the most energy-efficient and least carbon-intensive ways to transport goods (source: IEA, 2019).

Globally, in 2017, the total rail energy use was 53 million tonnes of oil equivalents (Mtoe) and it is estimated to reach 88 Mtoe by 2050. This is a 66% increase in the Base Case Scenario, or 125 Mtoe, by 2050, which is a 125% increase, in the High Case Scenario (Source: International Energy Agency (IEA) https://iea.net). Both scenarios project increased rail electrification, with half of the global rail freight moved using electricity. However, this is unlikely to be the case in North America.

Of all the long-distance transport sectors (Marine, Aviation, Rail and long-distance Trucking), rail emits the least amount of GHG emissions and provides the most efficient use of energy per tonne of freight/ passenger transported. Unlike aviation where Biojet/Sustainable Aviation Fuels (SAF) are likely to be the only short-to-mid term decarbonisation option, rail has other potential lower carbon options such as (green) electrification, the use low carbon biofuels, (e.g. renewable natural gas), hydrogen, etc. However, as will be described in more detail below, bio/renewable diesel can be readily used as a quickly deployable, low-carbon way of reducing the GHG emissions of North America's railways.

Similar to other regions, the transport sector is one of the major contributors of the GHG emissions in Canada. The Canadian transport sector emitted 186 Mt CO_2 eq (25% of total emissions) in 2019. This closely follows the oil and gas sector, which is the primary contributor of Canada's GHG emissions, accounting for 191 Mt CO_2 eq (Figure 2).

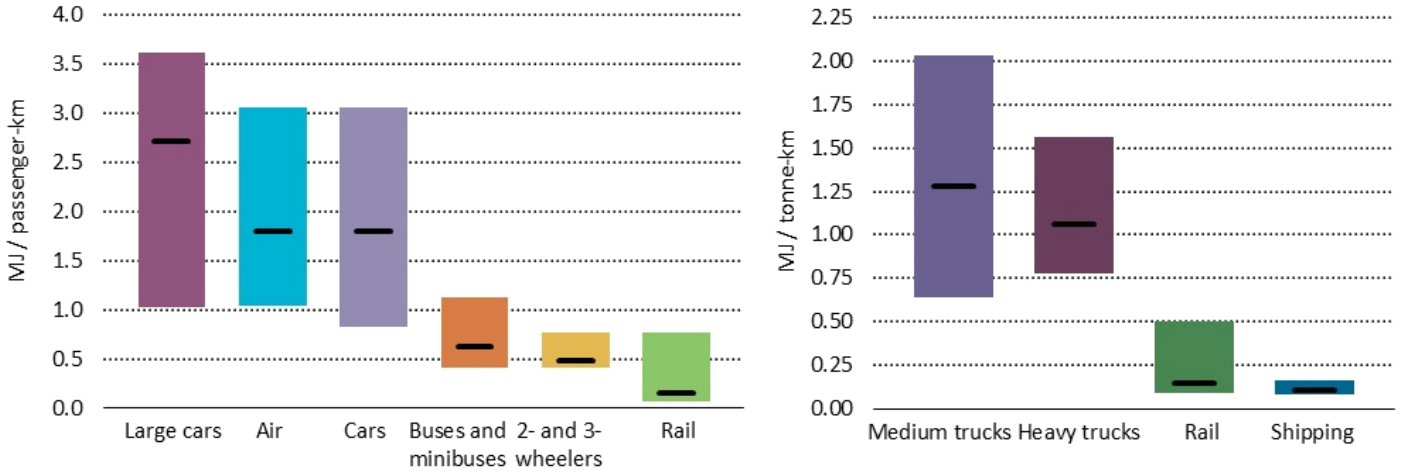

Figure 1: Energy intensity of different transport modes, 2017 (Source: IEA https://iea.net)

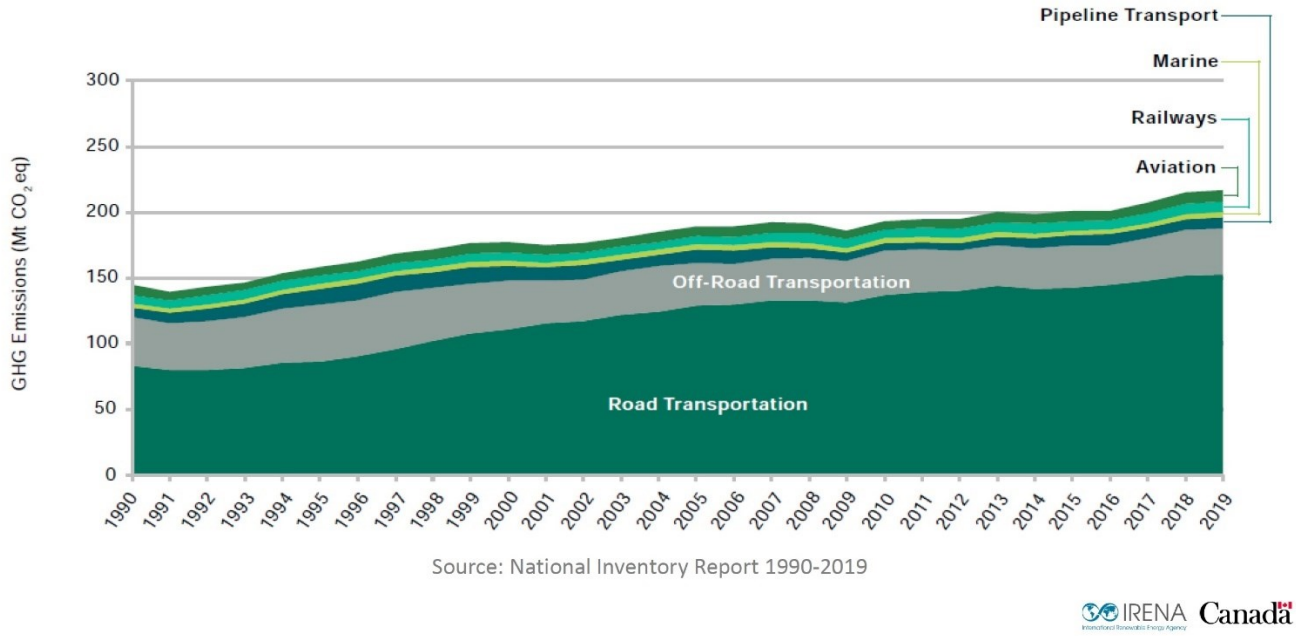

Figure 2: Emissions attributed to rail service in Canada were only 1% of total national emissions and 4.2% of transportation GHG emissions (a bit less than the aviation 4.4%). Freight operations accounted for 98% of rail greenhouse gas emissions (Source: Transport Canada).

In 2018, the rail sector emitted 7.8 Mt CO_2e, which was equivalent to 4.2% of domestic transportation-related greenhouse gas emissions and which was slightly less than the aviation sector (Figure 2). It should be noted that freight operations accounted for 98% of rail greenhouse gas emissions. According to the latest annual Locomotive Emissions Monitoring Report (2019), Canadian railways reduced their greenhouse gas emission intensity by 2.45 kg CO_2e per 1,000 revenue tonne kilometres as compared to 2010. This limited the net growth of greenhouse gas emissions in the sector to 0.2 Mt CO_2e from 2011 to 2017. This despite freight traffic increasing by 19.4% (revenue tonne kilometres) and intercity passenger traffic increasing by 4.1% (passengers) (Source: Transport Canada)

Canada's rail system is a critical component of its trade and transportation and it includes 41,465 km of track. The dominant freight rail operators are Canadian National (CN), which owns 52.8% (21,879 km) of rail line, and Canadian Pacific (CP), which owns 30.7% (12,709 km) of rail line. Other railways own 16.6% (6,812 km) of track. VIA Rail is Canada's major intercity rail passenger service operator, serving more than 450 communities across 12,500 km of track. In terms of equipment, in 2017, rail companies operated 2,280 locomotives, 47,759 freight cars (mainly hopper cars, boxcars, flatcars and gondolas), and 480 passenger cars. The Canadian rail sector generated approximately $10 billion per year, 95% of which comes from rail freight operations and approximately 5% from passenger rail services (Source: https://tc.canada.ca).

Over the last 10 years, Canada's rail sector consumed about 2.3 billion litres (BL) of diesel/yr. This was equivalent to 8% of the total diesel consumed in Canada in 2019. More than 29% of the rail-associated-diesel consumed in Canada in 2019 was

used in BC, followed by Ontario (24%) and Alberta (16%) (Source: https://open.canada.ca). Annually, Canada's railways moved over 100 million passengers and 70% of all intercity freight while producing about 4% of the country's transportation GHG emissions. Although freight rail is 3-4 times more fuel-efficient than trucking, railways also have an important role to play in supporting the Government's 2030 greenhouse gas emissions reduction and net-zero by 2050 goals (Source: The Railway Association of Canada (www.railcan.ca). For example, CN and CPR are actively reducing their emissions to meet respective 40% and 38% GHG emissions reduction targets by 2030.

Similar to other long-distance transport sectors (aviation, shipping and trucking), improved fuel efficiency is the primary way in which the rail sector hopes to reduce its GHG emissions. For example, the increased use of fuel-efficient locomotives, operational improvements, fuel management systems, zero-emission cranes, aerodynamics & lubrication, anti-idling tech and distributed power are just some of the ways this goal will be achieved. Since 1990, freight railways have reduced the intensity of their greenhouse gas emissions by over 40%, by improved fuel efficiency strategies (https://www.railcan.ca). However, these "increased efficiency" activities will not be enough if the rail sector is to meet its decarbonisation targets by 2050.

Although the rail sector is actively pursuing enhanced decarbonisation strategies, the sector is a capital-intensive and locomotives are long-term assets. Consequently, the use of some, "novel", low-carbon-intensive fuel options, such as the use of hydrogen, will be challenging as there are significant economic barriers to large-scale fleet replacement. For example, increased electrification of Canada's existing rail will be problematic due to the need for significant up-front investment. Similarly, zero-emission technologies such as battery-electric (CN), hydrogen and fuel cells (CP) for locomotives are still evolving and will require more testing and demonstration before commercialization. As each locomotive typically represents an investment of several million dollars, and engines are expected to last for upwards of forty years, any novel refueling infrastructure will involve considerable investment, costs and risk.

Although bio-based diesel has been mostly used by the Canadian road transportation sector, (primarily due to biofuels mandates and supporting policies), if the use of bio-based diesel by rail is to be encouraged, current and evolving provincial and federal GHG emissions regulations need to include this sector (i.e., allowing the rail sector to generate credits). Given the right support and opportunities, there is significant potential for Canada's rail sector to switch to using low-carbon-intensive fuels such as bio/renewable diesel.

This was highlighted in the recent BC-SMART webinar on "Decarbonising the rail sector using low carbon-intensive fuels", which is summarised below.

BC-SMART webinar on *"Decarbonising the rail sector"*

As mentioned previously, the BC-SMART Low Carbon Fuels Consortium is focussed on facilitating the decarbonisation the long-distance transport sector. To meet this goal, we were fortunate to recruit international speakers/panel members, who represent low carbon fuel producers, suppliers/distributors, end-users and policy advisors.

Moderator:

David Schick, from the Canadian Fuels Association (CFA)

Speakers/panel members:

Jacob Teter, *International Energy Agency (IEA)*

Marykate O'Brien, *U.S. Department of Energy Bioenergy Technologies Office (BETO)*

Ben Chursinoff, *Policy Analyst and Program Coordinator, Railway Association of Canada (RAC)*

Adam Sander, *Director, Emerging Markets, Renewable Energy Group (REG)*

BC-SMART/IEA Bioenergy Task 39 Virtual Panel Discussion: *"Decarbonizing the rail sector using low carbon-intensive fuels"* (Source: BC-SMART)

Jacob Teter, from the International Energy Agency (IEA) opened the webinar with an international perspective entitled *"The Future of Rail Opportunities for energy and the environment"***.** He described how the transport sector is a key source of global oil demand and emissions. Although rail is a key component of passenger and freight transport in many parts of the world its importance and role are often underappreciated. The question he raised was, "can rail respond to both rising transport demand and pressure from competing transport modes, further enhancing its energy efficiency and environmental benefits?" To answer this question, Jacob described the plusses-and-minuses of different modes of passenger rail movements (Figure 3).

As indicated, urban rail is uniquely positioned to provide high passenger throughput and, although capital costs per-kilometre are high, capital costs per throughput capacity is lower than that for urban car infrastructure.

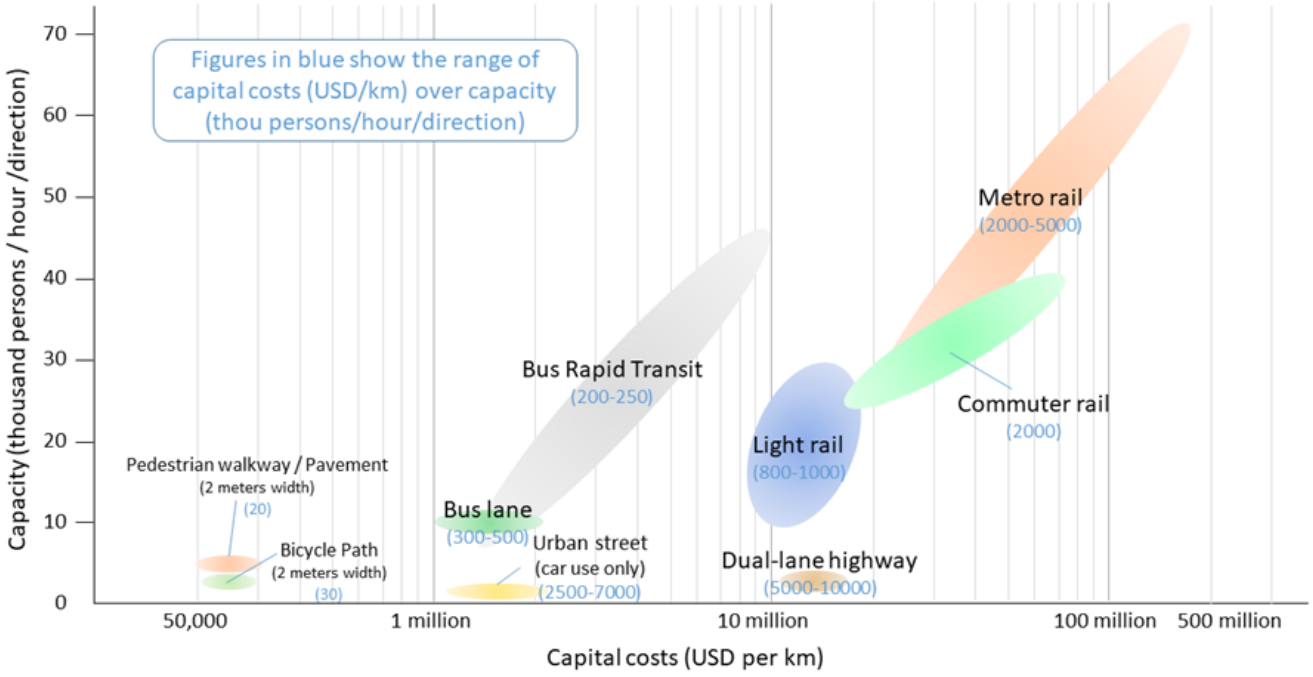

Figure 3: Costs and throughput capacities of urban transport infrastructures (Source: IEA https://iea.net)

Rail investments are readily justified in high-through-put corridors.

In 2016, passengers travelled over 4 trillion km (15% via high speed) by rail. Two-third of high-speed rail tracks are in China, followed by Japan (17%) and the EU (12%). **Both high-speed and urban rail are almost entirely powered by electricity while diesel fuel is the predominant fuel used for freight and conventional passenger train in some countries, particularly North America.**

Rail freight is typically based on the activity/region, the type of commodities transported (Figure 4), is very important in North America, Russia and China and is primarily used to move coal, crude oil, natural gas, minerals and agricultural derived commodities

Jacob followed his presentation with the question, "Can rail enhance greater GHG emission reductions?" He described how a comprehensive life cycle assessment (LCA) of the GHG emissions are depend on the characteristics of the infrastructure used (e.g., the construction of tunnels, viaducts and bridges are emission-intensive), its passenger throughput and its potential to displace other modes of transport. However, the efficiency of freight rail over road transport should result in clear net benefits.

Jacob proposed that the future of rail will be determined by how it responds to both rising transport demand and rising pressure from competing modes of transport. Through his work with the IEA he described Base-and-High Rail Scenarios, defining the Base Scenario as assuming, 1) no significant new emphasis on rail in policy making, 2) rail maintain its current share in global passenger activity relative to cars and air travel by 2050 and, 3) The global freight activity share falls from 7% in 2017 to 5% in 2050, growing less than shipping and road freight transport.

The High Rail Scenario was defined as, 1) greater reliance on rail for urban passenger movements and non-urban mobility, 2) this leading to CO_2 emissions in global transport to peak in the late 2030s and, 3) by 2050, an oil use that is more than 10mb/d lower than in the Base Scenario.

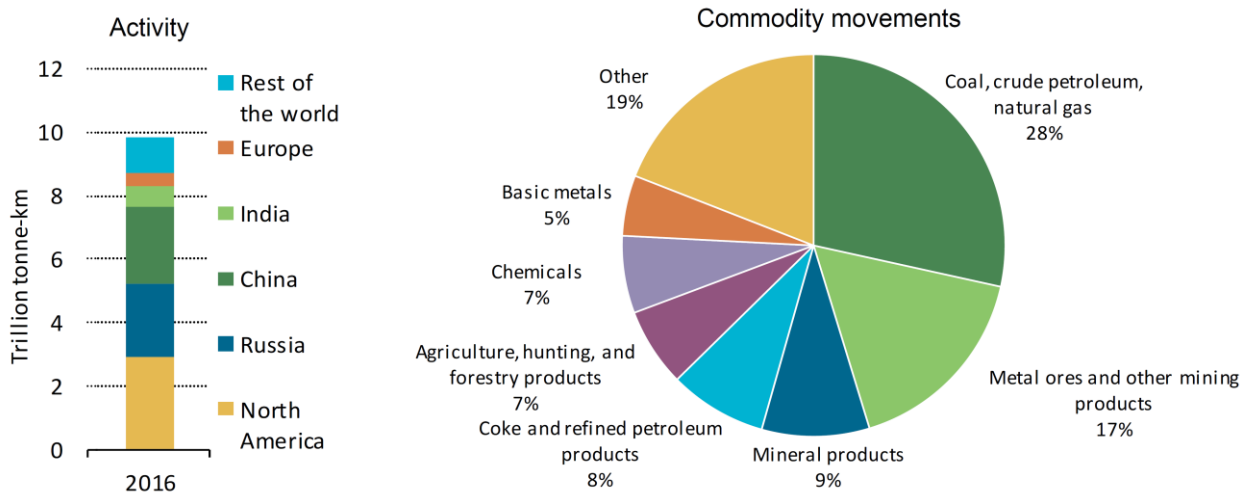

Figure 4: An overview of the rail freight transportation (Source: IEA https://iea.net)

This is also summarised in Figure 5, which shows changes in inland freight transport (High Rail vs. Base Scenario). In the High Rail Scenario, the increases in freight rail activity occur mainly at the expense of heavy trucks with the largest freight activity gains in China, North America, Russia and India. To achieve the reduced oil demand and GHG emissions that are described in the Paris Agreement will require a combination of the modal shift described in the High Rail Scenario with additional measures such as enhanced vehicle efficiency/electrification, the use of low-carbon fuels, and power sector decarbonisation. Although rail decarbonisation has considerable potential, it will require continued investment. It should be noted that freight rail activity doubles in the Base Scenario and grows even more in the High Rail Scenario.

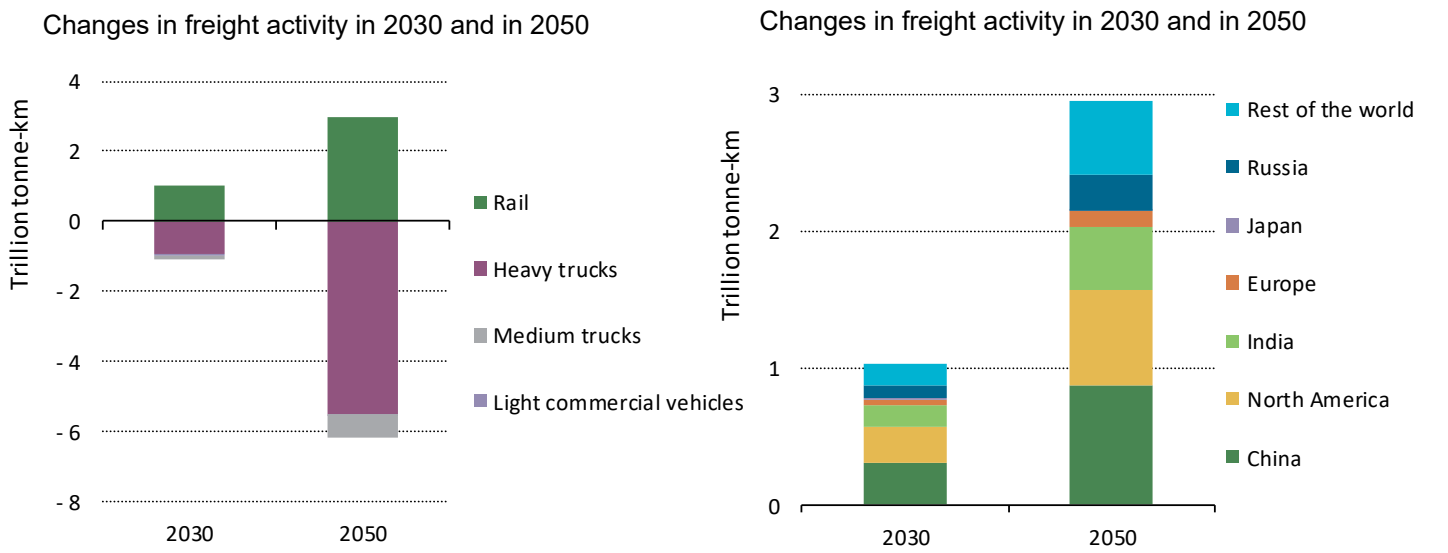

Figure 5: Change in surface freight transport activity (left) and freight rail activity (right) in the High Rail and Base scenarios, 2030 and 2050 (Source: IEA https://iea.net) **Key message:** For the High Rail Scenario, rail increases its market share of freight transport at the expense of heavy trucks. The largest freight activity gains are in China, North America, Russia and India.

Jacob Teter's presentation: **"The Future of Rail".**

Main Takeaways: Rail is an essential component of a comprehensive energy, GHG emissions reduction and overall transport strategy. The future of rail will be determined by rising transport demand and rising pressure from competing transport modes. Rail decarbonisation has considerable potential, but will require substantial investment.

Marykate O'Brien from the U.S. Department of Energy presented, "**Opportunities to Decarbonise the US Railroad Industry**". She first described a "Vision for Decarbonizing the Transportation Sector in the U.S". The U.S. Long-Term Strategy targets net-zero greenhouse gas (GHG) emissions by 2050 and a 50-52% reduction by 2030 (from 2005 levels). The US rail sectors emissions in 2019 contributed to about 2% of the country's total GHG emissions (6% of transportation) (Figure 6).

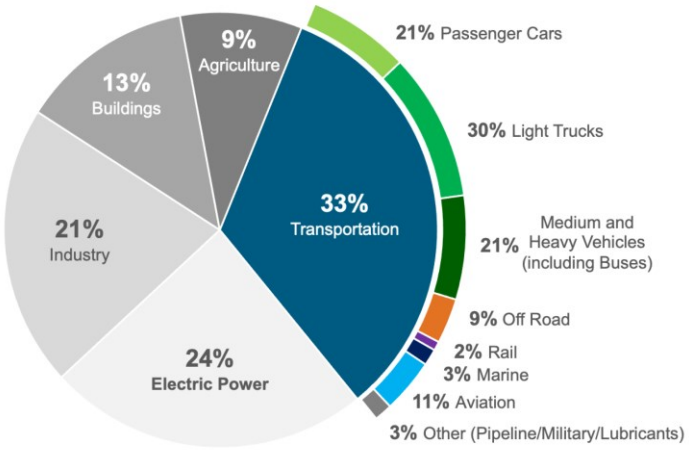

Figure 6: U.S. GHG emissions in 2019 (Source: Marykate O'Brien's presentation)

Rail transportation in the United States is dominated by freight shipments, which is supported by a well integrated network of standard gauge, private railroads extending into Canada and Mexico. By contrast, passenger service is mainly mass transit and commuter rail based in major cities. Intercity passenger service, once a large and vital part of the nation's passenger transportation network, plays a relatively minor role as compared to many other countries. The United States has the largest rail transport network of any country in the world and the $80-billion US freight rail industry provides 167,000 jobs and moves 28% of the country's freight by ton-miles. As summarised in Figure 7, freight accounts for the vast majority of the energy used by U.S. rail.

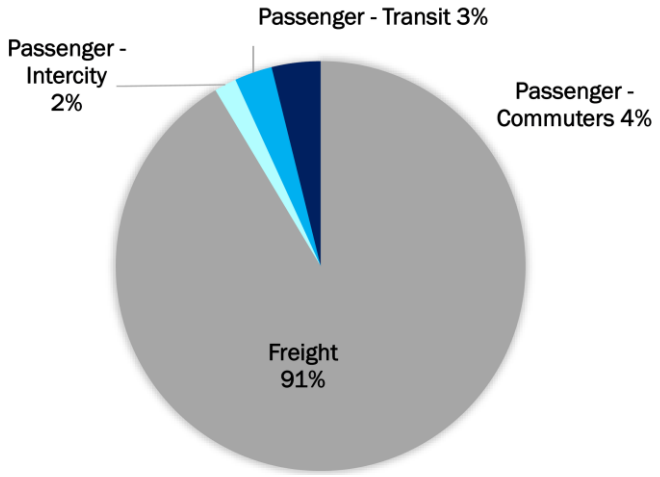

Figure 7: U.S. Rail Transportation Energy Use (Source: Marykate O'Brien's presentation)

Marykate also briefly described the various decarbonisation options that US rail is pursuing which, as summarised in figure 8, includes direct or battery electrification, hydrogen and low-carbon fuels such as bio/renewable diesel.

However, in the short-to-mid-term (2022-2035) options such as renewable diesel, biodiesel, e-methanol, ammonia and gaseous hydrogen are being assessed with a possible US roadmap for enhanced freight rail decarbonisation summarised in Figure 8.

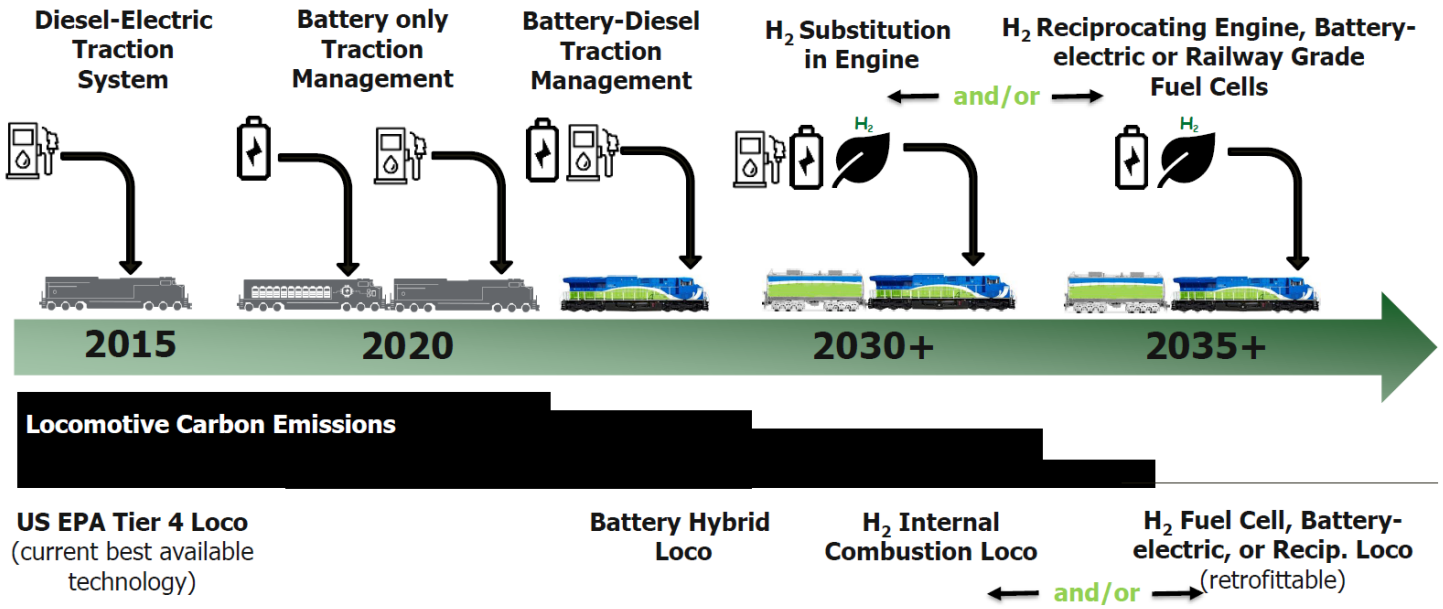

Figure 8: Possible roadmap of the U.S. to freight rail decarbonisation (Source: Marykate O'Brien's presentation)

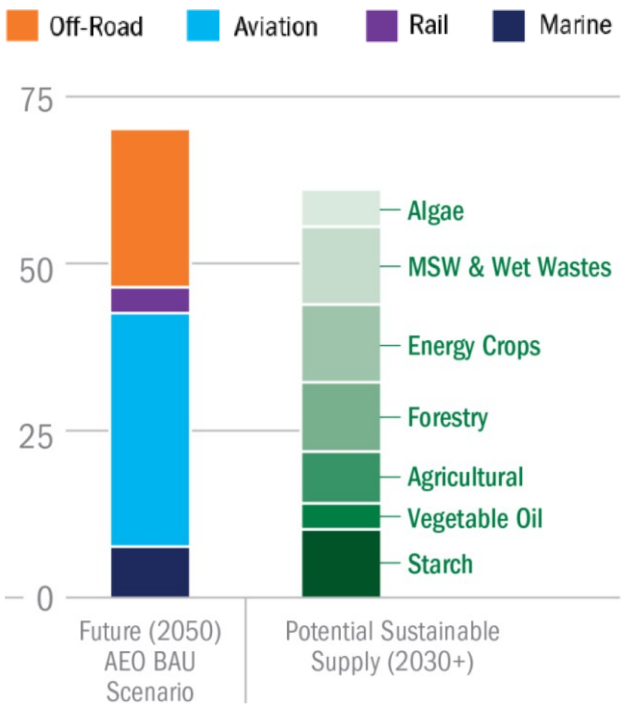

Figure 9: Projected liquid transportation fuel demand and biomass supply (Source: Marykate O'Brien's presentation)

AEO=Annual Energy Outlook | BAU=Business as usual GGE=Gasoline gallon equivalent | MSW=Municipal solid waste

However, although battery electric and H_2 (fuel cell/ internal combustion) can play an important role in decarbonising the rail sector, these options are not compatible with the existing fleet. By contrast, increased use of biofuels could help decarbonisation, with the possible liquid transportation fuel demand and possible sustainable biomass supply summarised in Figure 9. As the US can access 1 billion tons of biomass annually it has the potential to produce about ~62 billion GGE of biofuels. Consequently, most of the US's energy demand for the long-distance transport sector (off-road, aviation, rail and marine) could be supplied by sustainable biomass-to-biofuels.

Marykate O'Brien's presentation: **"Opportunities for Decarbonisation of the US Railroad Industry"**

Main Takeaways: Although battery electric and H_2 (fuel cell/ internal combustion) can play an important role in decarbonising the future US rail sector, biomass-to-biofuels has the potential to supply most of the energy demand needed by the US long distance transport

Ben Chursinoff, Policy Analyst and Program Coordinator from Railway Association of Canada (RAC) described how the rail sector in Canada might decarbonise. RAC represents close to 60 freight and passenger railways and includes 60 industrial railways and rail supply companies. In Canada, rail moves $320 billion worth of goods and tens-of-millions of passengers annually. Canada's rail network is 5th largest in the world and 12% larger than the country's highway system. As summarised in Figure 10, Canada's Railways are a very important component of the nation's economy.

A Memorandum of Understanding (MoU) was established between RAC and Transport Canada in 1995 to better manage locomotive emissions. The MoU described two main requirements of annual reporting of locomotive emission and the development of an action plan to reduce emissions.

Figure 10: The role of Canada's Railways on the economy (Source: Ben Chursinoff's presentation)

As illustrated in Figure 11, the GHG emission intensity of the Canadian rail sector has improved for both the freight and passenger sectors (by 44% and 42% respectively, compared to 1990/1991 levels). Similar to other long-distance transport sectors (aviation, shipping and trucking), improved fuel efficiency has been the primary way in which the rail sector has reduced its GHG emissions. CN and CP, as the main contributors to the rail freight in Canada, have significantly reduced their emissions, with target GHG reductions of 40% and 38% by 2030, respectively.

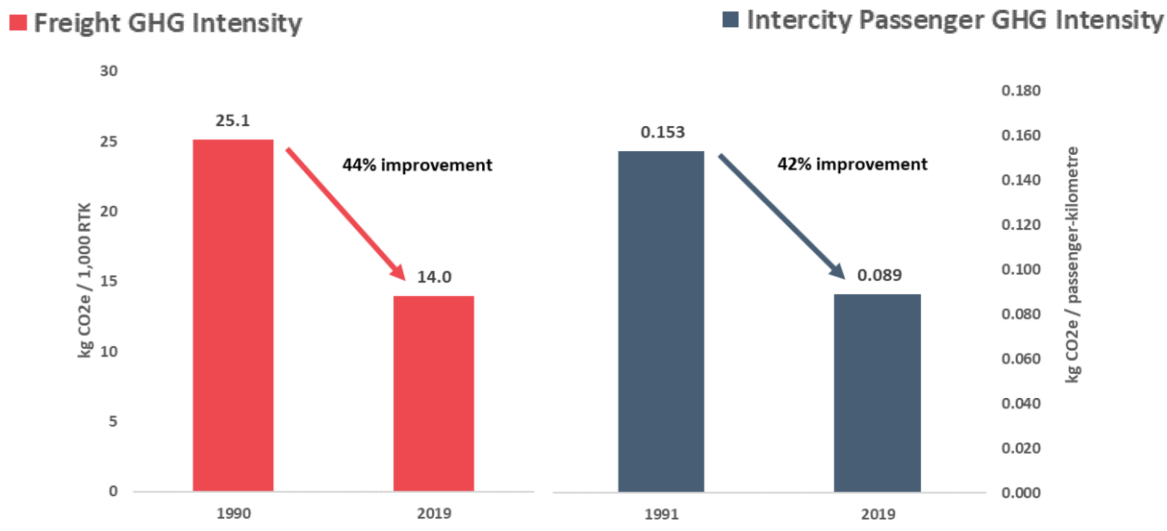

Figure 11: Improvement in GHG emission intensity of the rail sector in Canada (Source: Ben Chursinoff's presentation)

The Canadian Rail Pathways Initiative describes Phase 1 objectives of:

- Developing a common understanding of the current state of rail sector decarbonisation in Canada. It will be used as a tool for collaboration between industry and government;
- Creating an inventory of current federal, provincial and territorial GHG reduction legislative instruments and activities that impact the rail sector;

In response, the RAC has suggested that Canada's rail sector decarbonisation activities could be grouped by fuel efficiency measures, alternative fuels, alternative propulsion, infrastructure, and modal shift (Figure 12) (The report can be found here)

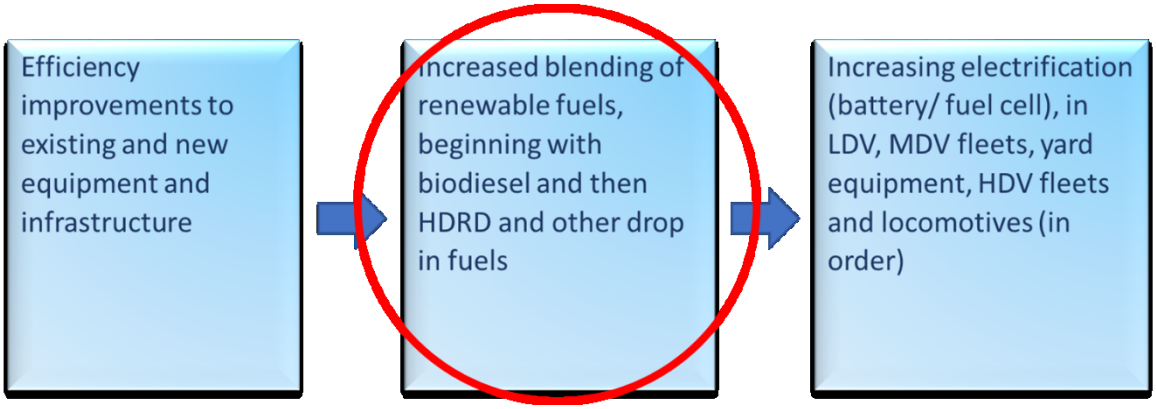

Figure 12: How Rail decarbonisation will look like (Source: Ben Chursinoff's presentation)

The RAC has also contributed to Phase 2 of the Rail Pathways Initiative, which plans to develop a Rail Decarbonisation Roadmap, with the following suggestions:

1. Develop an analytical framework to assess GHG reduction opportunities for Canada's rail sector

2. Identify and assess potential GHG reduction measures

3. Develop recommendations that will inform government and industry direction, and educate legislators

As renewable fuels manufactured from vegetable oils, animal fats, or recycled cooking oils will play a key role in the rail decarbonisation strategy, Ben reviewed the key considerations and benefits of using biodiesel and Hydrogenation-derived renewable diesel (HDRD)/ renewable diesel.

Ben Chursinoff's presentation **"People, Goods, Canada Moves by Rail"**.

Main Takeaways:

• Continue R&D focused on use of renewable fuels in the rail sector

• Blend levels should increase in the short-to-medium term, with further investment in R&D

• Policies such as Canada's Clean Fuel Regulation (CFR) will incentivise a transition to lower carbon fuels. But they need to be designed with rail in mind!

• The renewable fuels supply is expected to increase over time, eventually leading to more competitive pricing

• Although renewable fuels will be an important part of emissions reductions for rail, it is unlikely they will fully supplement petroleum diesel in the short-to-mid-term

• In the long term, all low-CI options need to be considered so that rail can achieve net-zero carbon emissions

Adam Sander, Director of Emerging Markets from REG, gave a presentation entitled "**Decarbonizing the Rail Sector with Bio-Based Diesel**". He described the production process and properties of biodiesel and renewable diesel. These are clean-burning, low-carbon fuels that offer an immediate way for rail to decarbonise. Although each of these options (biodiesel (BD) and renewable diesel(RD)) have some plusses-and-minuses, when blended and used together, renewable diesel and biodiesel offer additional synergistic benefits such as:

- RD provides significant NOx reduction
- BD provides lubricity, density and elastomer swell

A 50:50 blend of BD and RD is most similar to petroleum diesel regarding fluid properties and it has some performance benefits. These include the lowest overall engine emissions, superior lubricity, more similarity to conventional diesel and it can provide superior cold weather performance.

Adam described the GHG reduction targets of North American rail companies, which is more than 35% reduction by 2030 (Figure 13). He described how the use of bio-based diesels can help railroad companies meet their climate commitments.

Company	Science Based Target
Union Pacific	26% by 2030
BNSF Railway	*Committed to 30% by 2030*
CN	43% by 2030
CP	38.3% by 2030
Norfolk Southern	42% by 2034
CSX	37% by 2029
Kansas City Southern Lines	42% by 2034

Figure 13 GHG reduction targets of North American rail companies.

He also described how Canadian National and Union Pacific are both trialing 100% renewable fuel in their locomotives. The trials started earlier this year, with the CN trial in Pennsylvania and the UP trial in California.

Adam also discussed the need to take action now, as many environmental scientists consider GHG emission reductions to be critical. He described how (Figure 14) carbon dioxide accumulates and the GHGs emitted have a compounding effect on global warming, influencing the world's climate for many years to come.

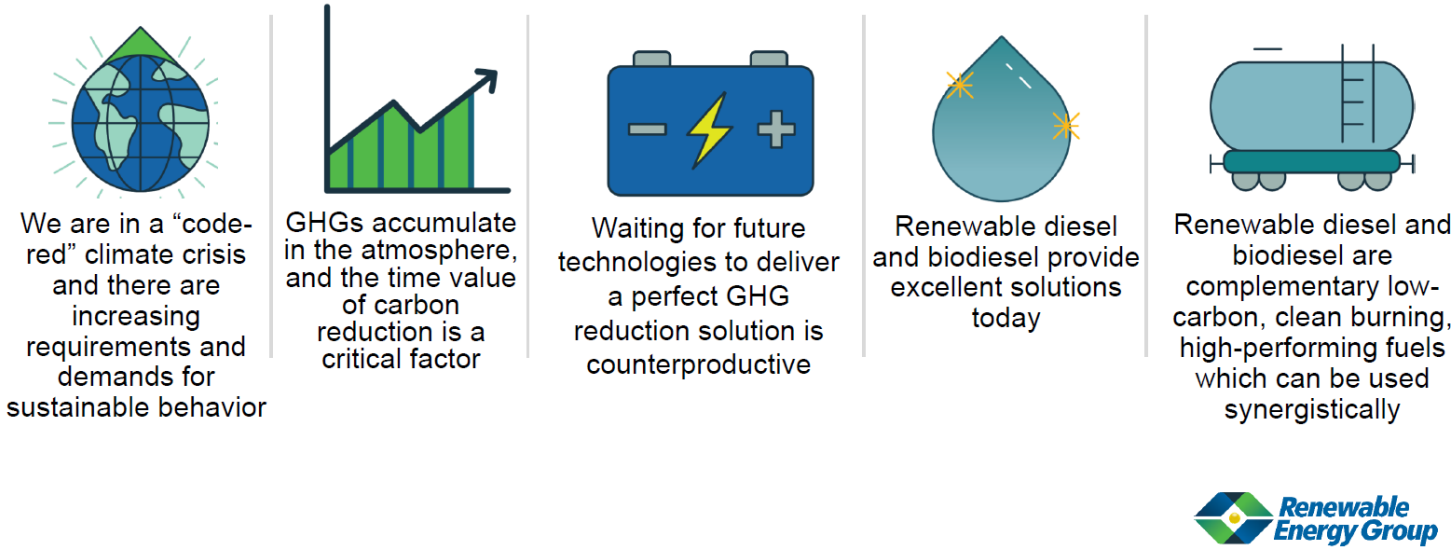

Figure 14: Concluding Remarks from Adam Sander's presentation

Summary

Unlike the aviation sector, where low-carbon-intensive (CI) biofuels are the only real decarbonisation alternative for the immediate future, rail has several low-CI options, such the use of "green" electricity, "green" hydrogen, renewable natural gas (RNG), biofuels, etc. However, as described by the panelists, low-CI, bio/renewable diesels are likely to predominate due to their more "drop-in" nature. This includes the use of much of the oil refining's current infrastructure and the increased use of lower-CI oleochemical/lipid feedstocks.

Bio-based diesels have been mostly used by the road transportation sector, primarily due to biofuels mandates and supporting policies. To encourage the use of bio-based diesels by the rail sector, current and evolving GHG emissions regulations need to include rail (i.e., allowing the rail sector to generate credits). Given the right support and opportunities, there is significant potential for Canada and the worlds rail sector to switch to using more low-carbon-intensive fuels.

As more fully described in the panel discussions, it is highly likely that bio-based diesels, including biodiesel and renewable diesel, will play an increasing role in meeting Canada and the worlds GHG reduction targets. Although the rail sector will continue to assess and monitor alternative technologies (hydrogen, electric, battery/fuel cell electric, etc.), "feedstock challenged" countries are probably more "motivated" to take the lead in assessing these low-CI fuel alternatives, particularly at the trial/demonstration scale.

In the BC-SMART report entitled, "The potential to decarbonise rail using low-carbon intensive fuels, particularly drop-in biofuels", displacing 20% of the current diesel used by the Canadian rail sector with bio-based diesels (460 million liters), could reduce the GHG emissions of the rail sector by more than 1.36 Mt per year (16.5% of the sector). Although this

is currently equivalent to about 50% of Canada's bio-based diesel production capacity, the bio/renewable diesel production in Canada is expected to increase significantly in the near future

Due to its "feedstock advantages" and "enabling policies", bio-based diesels can quickly provide a low-carbon fuel solution for the Canadian rail sector with minimum/no up-front cost and significant (up to 84%) GHG reduction potential.

However, despite the current highs price of fossil fuels, the higher price of bio-based diesels is a major concern while original engine manufacturer (OEM) warranties limit biodiesel blends to 5% and renewable diesel blends to 30%. Despite these challenges, higher blends of bio-based diesels are likely to be approved by OEMs in the near future while supporting policies such as BC's Low Carbon Fuel Standard (LCFS) and Canada's Clean Fuels regulations (CFR) will help bridge the price gap between conventional diesel and bio/renewable diesels.

If you would like to be part of the **"Coalition of the Willing"** and continue to receive our newsletter and occasional updates about BC-SMART consortium, please contact us at:

Contact (BC-SMART secretariat):
Dr. Mohsen Mandegari
Email: m.mandegari@ubc.ca