



## The Road to 2050

Bridging the Gap Between Challenges & Solutions in the Transportation Sector

# Transportation

## Bridging the Gap Between Challenges and Solutions in the Transportation Sector

Emissions from the transportation sector are a major contributor to climate change, accounting for 38% of carbon emissions in BC. As the population in BC grows, so does the demand for a modern, clean and effective transportation infrastructure.

The transportation sector impacts all sectors of the economy - the infrastructure and vehicles that ensure efficient movement of people and goods across the province are vast and complex and include roads, railways, airports, shipping ports, warehouses and an array of vehicles: light duty, trucks, buses, rail and rapid transit, ferries, ships, and airplanes.

The Province of British Columbia, through their progressive CleanBC program, has set province-wide GHG emissions reduction targets of 40%, 60% and 80% for 2030, 2040, and 2050. In particular, for the transportation sector, the CleanBC plan specifies:

- By 2030, 30% of all sales of new light-duty cars and trucks will be zero-emission vehicles, rising to 100% by 2040
- To help meet increased demand for lower-carbon fuels, B.C. will support the production of 650 million litres of renewable fuels per year
- The Province will reduce GHG emissions from government vehicles by 40%
- The carbon intensity of fossil fuel for transportation will be reduced by 20% by 2030

For the transportation industry to meet these targets, it will require strategic investment in low or net zero carbon technologies, and a wide scale coordinated effort between the multiple stakeholders involved in making the decisions that shape transportation in this province.

CORE Cleantech Cluster and Foresight are producing a series of roadmap landscapes in the six sectors of CORE's focus. This introductory document is meant to provide a snapshot of the roadmaps in use in the transportation sector in BC, to provide a strategic overview of the path to the targets for 2030-2050, and to identify areas where the industry would benefit from further support in order to achieve the targets.

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Photographer: William Jans

## What's At Stake

- Transportation accounts for 38% of carbon emissions in BC.<sup>1</sup>
- Clean energy vehicle sector generates over \$702 million in total direct economic activity.<sup>2</sup>
- Transportation and Warehousing industry employs approximately 138,000 people in BC.<sup>3</sup>
- The federal government, through NRCAN, is providing \$130M over five years (April 2019 to March 2024) towards electric vehicle and alternative fuel infrastructure funding.<sup>4</sup>
- An effective transportation system plays an important role in meeting economic, social and environmental goals across the province.







Photo courtesy of Vancouver Fraser Port Authority  
Photographer: William Jans

## How Are We Getting There? The Roadmap Matrix

The following is a matrix of the roadmaps and action plans in use in the province organized by industry-sub sector/transport method:

	LIGHT DUTY	TRUCKS	BUSES (TRANSIT)	RAIL	FERRIES	OCEAN SHIPPING	SHORT HAUL AIR	LONG HAUL AIR
<u>Clean BC Plan</u>	✓	✓						
<u>Transportation 2040, City of Vancouver</u>	✓	✓	✓			✓		
<u>BC Bioenergy Network Hydrogen Plan</u>	✓	✓	✓	✓	✓	✓		
<u>Northwest Ports Clean Air Strategy</u>		✓		✓		✓		
<u>Translink Regional Transportation Strategy</u>			✓					



There are multiple roadmaps and strategies that are guiding the decision-making in the transportation sector. This is no surprise given the diverse stakeholders across the province with different priorities and requirements, and the importance of transportation in terms of emissions reduction. With so many stakeholders, there will be areas of overlap and agreement, as well as areas where technology and business needs will push groups in opposite directions.

For example, in the transportation sector, there are competing low or zero carbon technologies under consideration that roughly break down by vehicle type and sector:

	LIGHT DUTY	TRUCKS	BUSES (TRANSIT)	RAIL	FERRIES	OCEAN SHIPPING	SHORT HAUL AIR	LONG HAUL AIR
Battery Electric	✓	✓	✓	✓	✓		✓	
Trolley Electric		✓	✓	✓				
Hydrogen / Fuel Cell Electric Vehicle	✓	✓	✓	✓	✓			
Synthetic Liquid Fuels					✓	✓	✓	✓
Liquefied Natural Gas / Compressed Natural	✓	✓	✓		✓	✓		
Gas	✓	✓	✓		✓	✓		

In Use

In Piloting or Used Elsewhere

Under Consideration / In Development



We expect that we're going to be five years ahead of our own schedule.<sup>5</sup>

- Hon. Michelle Mungall, Minister of Jobs, Economic Development and Competitiveness, referring to the adoption rate of electric cars in BC

## Technology Adoption

As the province moves toward the CleanBC goals and decarbonization of the economy, there has been significant activity led by both government policy and private enterprise across a number of disruptive technologies. The industry, which has arguably been around since the invention of the wheel, is undergoing a renaissance of new innovations that are forcing a re-look at the fundamentals of transportation in the province - from the individual on public transport to the large ships in Vancouver harbour.

Interviews with a cross-section of industry players revealed a number of low carbon technologies and fuels that are being developed and adopted in multiple areas of the transportation sector:

- **Light Duty Electric (Passenger) Vehicles** - The good news for British Columbia is that because of progressive Zero Emission Vehicles policies and incentives for consumers put in place by the provincial government, electric vehicle sales in B.C. are the highest per capita in North America, making up nine per cent of light-duty vehicles that are being sold in the province.<sup>6</sup> While this 'ahead of schedule' adoption of electric vehicles by the consumer may lead to capacity challenges in the provincial power grid<sup>7</sup>, it is also a significant opportunity for innovation in vehicle-to-grid technologies such as AI-based energy optimization systems.
- **Long Haul Trucking** - There is common agreement that long haul trucking is a critical sector for which there is currently no proven path to sustainability. Work is being done on both battery electric vehicles (BEV) and Fuel Cell Electric Vehicle (FCEV) options. Issues around vehicle cost, lack of infrastructure, and technology immaturity are not fully resolved. (For example, current price estimates for FCEVs are almost double BEV trucks, which are already significantly more expensive than diesel.) Independent industry analysts predict that FCEVs will be a bridge technology until BEV's and grid infrastructure are able to provide the necessary range.<sup>8</sup>



The industry is changing since we know we can't build ourselves out of congestion anymore and there needs to be an alternative solution.<sup>9</sup>

- Erinn Pinkerton, President and CEO, BC Transit



Photo courtesy of Vancouver Fraser Port Authority

- **Buses** - BC Transit, through their low carbon fleet program, has committed to the electrification of their fleet in stages, and have announced plans to replace over 1,200 existing buses and add another 350 over the next 10 years, with the goal of having an entire fleet of electric buses by 2040.<sup>10</sup> Translink has recently released (Feb 2020) a low carbon fleet transition plan that outlines recommended paths toward reducing annual fleet GHG emissions by 90+ percent from 2007 levels in 2050 through electrification of the bus fleet (including 40-ft and 60-ft transit buses, 40-ft highway coaches, and shuttle buses).<sup>11</sup>
- **Rail** - British Columbia serves as the western node of a large and well developed coast-to-coast rail system that transports mainly freight, covers 49,422 km (30,709 miles) of track and is dominated by CN and CP. While there are Canada-wide R&D projects investigating rail electrification, use of biofuels and hydrogen rail<sup>12</sup>, the railway industry has focused their carbon reduction efforts on what has been called “precision railroading” - technology and process improvements such as low-idle features designed to save fuel, automatic stop/start systems, and rail lubrication.<sup>13</sup> West Coast Express operates a commuter passenger rail service with a ridership of 11,000, and may provide an opportunity for a BC demonstration of low-carbon railroad technology.
- **Ocean Shipping** - Ocean Shipping is a global industry, and in terms of ships and marine vehicles, The International Maritime Organization (IMO) are in the second phase of developing a roadmap for the reduction of GHG emissions from shipping. While small marine vehicles may go electric, the main research focus for shipping will be LNG/CNG and sustainable fuels. This represents an opportunity for BC, as focussed research on finding cost effective synthetic fuel (possibly from clean hydrogen and/or biomass) could result in a potential new industry.



They're designed to go full electric when the shore infrastructure permits.<sup>14</sup>

- BC Ferries CEO Mark Collins

- **BC Ferries** - BC Ferries have a plan for large LNG-Hybrid ferries using BC-built battery technology. They have also recently announced smaller hybrid electric-diesel ferries and have made a commitment to electrification of the fleet.<sup>15</sup> Shore infrastructure is a stumbling block to full electrification, as the current infrastructure at the terminals do not support vessels plugging in and recharging between runs. As a result of financial pressures coming out of the COVID-19 pandemic, some of these plans are set to be postponed.
- **Short Haul Air** - Harbour Air is a BC aviation company that flies a fleet of more than 40 propeller-driven seaplanes. It flies 500,000 passengers per year and wants to become the “world’s first all-electric airline”. It is an example of the type of air travel that electrification is most suited for: small aircraft going short distances (all of Harbour Air flights are less than 30 minutes). Electrification is a proven path for these types of aircraft and airlines. For longer trips or larger airplanes, short haul air may also convert to renewable low carbon fuels, which is another competing technology.
- **Long Haul Air** - For long haul air, the situation is similar to shipping - the airline industry is global, and aircraft are subject to global regulations. In terms of airlines adapting technologies, they will follow global standards - CORSIA - Carbon Offsetting and Reduction Scheme for International Aviation. This global roadmap includes sustainable fuel standards, and phased approaches for introducing biofuels or other renewable fuels.
- **Facilities** - In addition to transport vehicles and roads there are significant transportation infrastructures in the province - airports, bus transit and ferry terminals, ports, railyards. In these cases, the path to decarbonization is site specific. Many are focusing on reducing their operational carbon footprint through increased efficiency and electrification.
- **Industry** - Within industries, most will follow the technological pathways outlined above that are best matched with their transportation needs. Industries that use large or specialized equipment for movement of goods or materials may pursue developing new technologies independently. For example, the mining industry is exploring a range of options including trolley electric and hydrogen in order to power their large haul trucks.







Photo courtesy of Hydra Energy

## Recommendations:

The transportation sector is a leading source of greenhouse gas pollution in the province and will have a significant role to play in achieving CleanBC targets.

The good news for the province is that there are many competitive advantages that could be leveraged to develop this industry further: progressive legislation, mature cleantech companies (esp. in hydrogen/fuel cells, electrification/ batteries), high adoption rates of electric vehicles, a local refinery providing blended low carbon fuels, transportation infrastructure and geographic proximity to Western US states with emergent clean transportation and aviation sectors, along with proximity to rail, truck and port facilities. (see report [Accelerating British Columbia's Clean Economy: A Cleantech Cluster Strategy for the Province of British Columbia](#)).

These competitive advantages, along with the array of low/zero carbon technologies and approaches outlined above provide a unique opportunity to support a clean transportation economy in BC, create jobs and wealth while aligning with policy.

Transportation is a global industry. While some decision pathways and technologies will be 'made-in-BC' and implemented here, some technology adoption pathways will be determined by national and global interests and economics. Also, while some of the technologies noted above are fully operational, many are also still in development.

This means the industry is in flux, and it is likely that the future will see increased diversity in the number of technological choices and fuels available. It also means that the research and development (R&D) culture and innovation support system in BC along with government commitment to long-term progressive policies will continue to be vital as this significant sector undergoes rapid change.

It will be increasingly important to enhance the innovation ecosystem through coordination networks and activities that help align industry needs to technology development and funding (and encourage international partnerships and knowledge sharing).



## Decarbonizing Transportation: Strategic Decisions on The Road Ahead

### The High Priority Recommendation

In the recently published roadmap landscape report for the energy sector [The Road to 2050 - Bridging the Gap Between Challenges and Solutions in the Energy Sector](#), the high priority recommendation was that a provincially-led decision tree must be developed that provides guidance around key issues and major technology pathways. The decision tree should outline the path ahead around big picture decisions and infrastructure investments.

Given the significant interdependencies and linkages between energy and transportation, the high priority recommendation for transportation is similar. Along with the energy decision tree, a transportation strategy and roadmap that defines how the transportation sector will decarbonize in step with changes to the energy pathway and infrastructures should be created.

While many of the decarbonization decisions for various modes of transportation will be driven by national and global economics and frameworks, in the context of BC, the sub-sector of long haul trucking is of particular interest. As noted above, long haul trucking is a critical sector for which there is currently no proven path to sustainability.

### Opportunities

Could this open an opportunity for BC to prove a path to sustainability in long haul trucking and develop an industry and export market in decarbonization of this sub-sector? Given the competitive advantages that BC has in this sector, and our natural testing ground of long highway stretches, high elevation mountain passes and winter conditions, with the guidance of big-picture decision trees in both energy and transportation, BC could become a cluster of innovation in developing technology solutions for commercial medium and heavy longer range transportation modes.

Opportunities also exist in other sub-sectors, such as in electric and LNG-Hybrid ferries or in cost effective synthetic fuels for long distance shipping or air travel.

A decision tree style roadmap for decarbonization of transportation could provide an assessment of these opportunities in terms of market opportunities, technological development pathways and investment priorities.

Photo courtesy of Vancouver Fraser Port Authority



### **The Stumbling Block**

However, as in the energy sector, uncertainties concerning the long-term direction of the transportation sector may be slowing down the adoption and development of new technology. Decisions in the energy sector regarding future energy sources and fuels, in particular the balance between electrification and alternative fuels such as hydrogen in large-scale infrastructure planning and investment, will have a direct impact on transportation.

It is also worth noting that recent independent research predicts that over the long term, battery electric vehicles may be the most cost effective and fuel efficient mode of transportation, even for long haul trucking<sup>16</sup> and rail.<sup>17</sup> Hydrogen and fuel cell electric vehicles may be an important bridge technology until battery electric vehicles and grid infrastructure are able to provide the necessary range. They may also have a role to play in heavy industry or other industrial markets.

(See the [The Road to 2050 - Bridging the Gap Between Challenges and Solutions in the Energy Sector](#) report for a discussion regarding the need for provincial guidance around the nature and scope of BC's hydrogen economy).

### **Moving Forward**

There is an array of possible approaches to the decarbonization of transportation in BC, and a number of competing technologies, many in full commercialization and proven either in Canada or elsewhere. BC has all the raw ingredients for a leadership position in specialized sub-sectors of the transportation industry, and should leverage its strengths to create a local and export market for commercial medium and heavy longer range transportation technologies.

In order to move forward both in developing new opportunities for BC's transportation technology SME's and to achieve CleanBC goals in the transportation sector, top level transportation strategies and roadmaps must be created in step with the decision tree around energy pathways and infrastructures recommended in the recently published landscape report for the energy sector ([The Road to 2050 - Bridging the Gap Between Challenges and Solutions in the Energy Sector](#)).





# BC has all the raw ingredients for a leadership position in transportation.<sup>18</sup>

- CORE Cleantech Cluster Roundtable participant

The following are concrete recommendations for action:

## Long Haul Trucking

A decision matrix should be created to guide infrastructure planning for the long haul trucking industry. This will help both governments and industry to determine when and what charging or fueling stations need to be built, along with identifying the key trucking corridors along which they need to be installed, and how this would impact the overall economics of transportation. This should be done in cooperation with other provinces (particularly AB, Sask, MB and Ont) and the western US states, and in step with a provincial energy decision tree. (See previous section “Decarbonizing Transportation Strategic Decisions on The Road Ahead”)

The decision matrix should then guide the development of a) government policy that ensures sufficient installation of electric charging and/or hydrogen fueling stations to allow for the rapid adoption of the vehicles for commercial medium and heavy longer range transportation, and b) funding and financing mechanisms that will encourage innovation and adoption of clean long-haul trucks.

## R&D/ Investment

Accelerating the decarbonization of BC Ferries is an opportunity to develop both local expertise and an innovative export market in both electric and LNG-Hybrid ferries (and infrastructure). While Norway leads the world in all-electric ferries, they don't have the tidal conditions that we have in BC, which leads to an opportunity to lead in decarbonization of ferry operations for geographies with significant tides. Government funding (federal or provincial) could accelerate BC Ferries' plan for new LNG-Hybrid ferries, get the delayed project moving forward, and increase the BC and Canadian content of them.

Achieving carbon neutral long distance shipping and air travel are global issues for which synthetic fuels may be the best option. In a BC context, focussed research on finding cost effective synthetic fuels leveraging BC expertise (possibly from clean hydrogen or biomass) could result in a potential new industry for BC.

As there are a number of Canadian battery electric bus manufacturers, there may be opportunity for the federal government to accelerate the adoption of battery electric buses through the expansion of funding programs (such as the Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative) to include battery electric bus manufacturers.

## Passenger Vehicles

In addition to the successful ZEV incentive program, a fee-bate system is recommended as a way to further accelerate ZEV adoption. This would involve adding a charge onto the purchase of higher emission vehicles which would fund rebates for ZEVs, with the magnitude of the charge commensurate with the level of emissions. This revenue-neutral approach could create a larger incentive for the consumer as it brings the incentive forward to the time when the purchase decision is made, rather than the carbon tax which kicks in after a vehicle has already been purchased.

Results from several European countries indicate that CO2-based vehicle taxation has had a significant impact on reducing new vehicle emissions rates and increasing market share of vehicles with lower emissions.<sup>19</sup>





## About the Project

The CORE Cleantech Cluster is driving economic development goals of job growth, company growth, investment attraction and trade opportunities in British Columbia by activating, coordinating and developing collaboration opportunities and energizing an innovation ecosystem centred around cleantech and sustainability.

A more detailed analysis of the Transportation Sector and its role in the cleantech innovation ecosystem is available in the report [Accelerating British Columbia's Clean Economy: A Cleantech Cluster Strategy for the Province of British Columbia.](#)

# Foresight

## About Foresight Cleantech Accelerator Centre

This roadmap landscape report is funded through [Foresight Cleantech Accelerator Centre](#). Foresight is Western Canada's Cleantech Innovation Centre which supports the identification and validation of cleantech opportunities and the successful commercialization of solutions.

<sup>1</sup> The Province of British Columbia. Climate Action in BC 2018 Progress to Targets 2018

<sup>2</sup> Clean Energy Vehicle Economic Opportunities Assessment, Prepared for the BC Ministry of Energy and Mines, August 2016

<sup>3</sup> <https://www.workbc.ca/labour-market-industry/industry-information/industry-profiles/transportation-and-warehousing>

<sup>4</sup> <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/electric-alternative-fuel-infras/electric-vehicle-alternative-fuels-infrastructure-deployment-initiative/18352>

<sup>5</sup> <https://vancouversun.com/news/local-news/number-of-electric-vehicles-on-b-c-roads-on-the-rise-province>

<sup>6</sup> <https://vancouversun.com/news/local-news/number-of-electric-vehicles-on-b-c-roads-on-the-rise-province>

<sup>7</sup> Applied Energy Journal, November 2019, [Electrification of road transportation with utility controlled charging: A case study for British Columbia with a 93% renewable electricity target](#)

<sup>8</sup> <https://nacfe.org/report-library/guidance-reports/>

<sup>9</sup> <https://onlineacademiccommunity.uvic.ca/gustavson/2020/01/08/road-to-success-the-future-of-public-transit-in-bc/>

<sup>10</sup> <https://www.bctransit.com/low-carbon-fleet-program>

<sup>11</sup> [https://www.translink.ca/-/media/Documents/about\\_translink/corporate\\_overview/policies/translink\\_low\\_carbon\\_fleet\\_transition\\_plan\\_20200224.pdf](https://www.translink.ca/-/media/Documents/about_translink/corporate_overview/policies/translink_low_carbon_fleet_transition_plan_20200224.pdf)

<sup>12</sup> <https://www.energy.gov/sites/prod/files/2019/04/f62/fcto-h2-at-rail-workshop-2019-belluz.pdf>

<sup>13</sup> <https://www.railcan.ca/101/innovation/>

<sup>14</sup> <https://www.cbc.ca/news/canada/british-columbia/bc-ferries-hybrid-vessel-launch-1.5296957>

<sup>15</sup> <https://www.cbc.ca/news/canada/british-columbia/bc-ferries-hybrid-vessel-launch-1.5296957>

<sup>16</sup> <https://nacfe.org/report-library/guidance-reports/>

<sup>17</sup> <https://www.railjournal.com/technology/vde-study-finds-battery-trains-35-cheaper-than-hydrogen/>

<sup>18</sup> <http://corecleantech.com/>

<sup>19</sup> <https://theicct.org/publications/effectiveness-co2-based-feebate-systems-european-passenger-vehicle-market>