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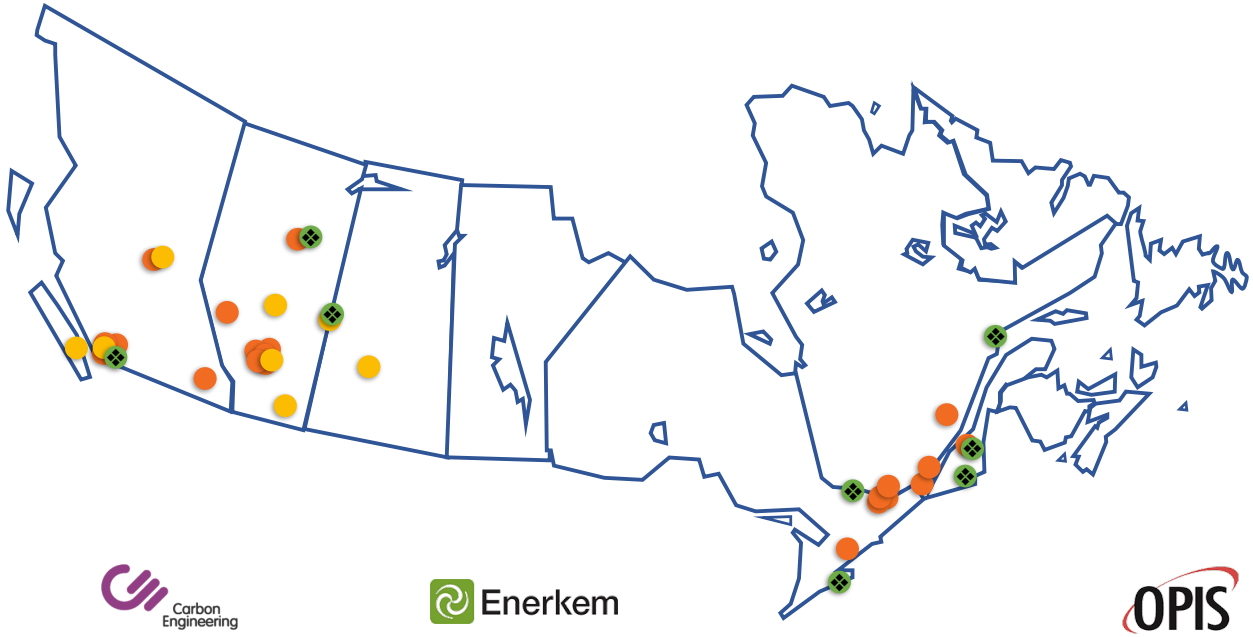
Decarbonizing Transportation: How Are Clean Fuel Programs Changing the Transportation Industry Paradigm to a Low Carbon Economy

Part 1: Clean Fuel Regulation Impact, Outlook

February 11, 2021

Ian Thomson
President

Advanced Biofuels Canada - Members



- Production
- Processing
- Office/Research

ADM
Carbon Engineering
Enerkem
OPIS
TARGRAY
argus
CONSOLIDATED BIOFUELS Ltd.
ENSYN
INNOLTEK INNOVATION RENOUVELABLE
REG Renewable Energy Group
Verbio
CANADA CLEAN FUELS
ecoengineers people-driven solutions
HALDOR TOPSOE
IOGEN CORPORATION
steeper ENERGY The Renewable Oil Company
vorsana
CANFOR
ELBOW RIVER
Honeywell UOP
LanzaTech
StoneX
WEST COAST REDUCTION LTD.

Advanced Biofuels Canada:
Diverse Technologies, Products

Technologies:

Innovation

- Bio-chemical
- Thermo-chemical
- Transesterification
- Biomass co-processing
- Catalytic de-polymerization/ hydrothermal liquefaction
- Catalytic upgrading
- Gas fermentation
- Hydrotreating
- Direct Air Capture

Products:

Low Carbon Fuels

- Advanced Ethanol
- Biocrude
- Biodiesel
- Biogas (H_2, RNG)
- Biojet
- Bio-methanol
- Renewable Fuel Oil
- Renewable Gasoline
- Renewable Hydrocarbon Diesel (HDRD)
- Synthetic Diesel

Co-Products:

Bio-Products

- Bio-chemicals
- Fatty acids
- Glycerin
- Animal feed & nutritional supplements
- Green polymers
- Light & heavy fuel 'ends'
- Liquid CO_2
- Phosphate
- Renewable naphtha
- Renewable Liquid Petroleum Gas (R-LPG)

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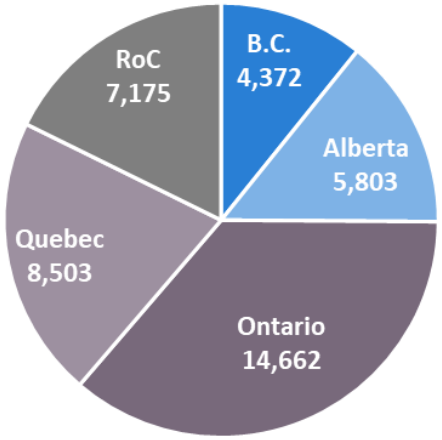
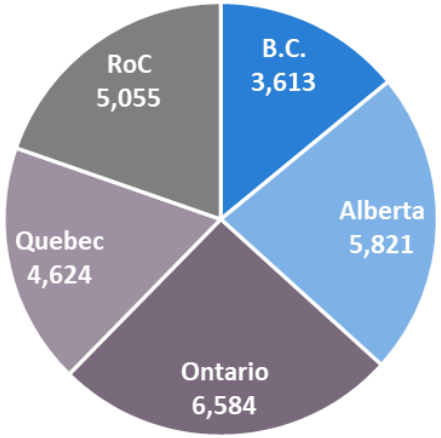
Canada — Transportation Fuel Use, Imports

2019 Gasoline Use (million litres)



2019 Diesel Use (million litres)

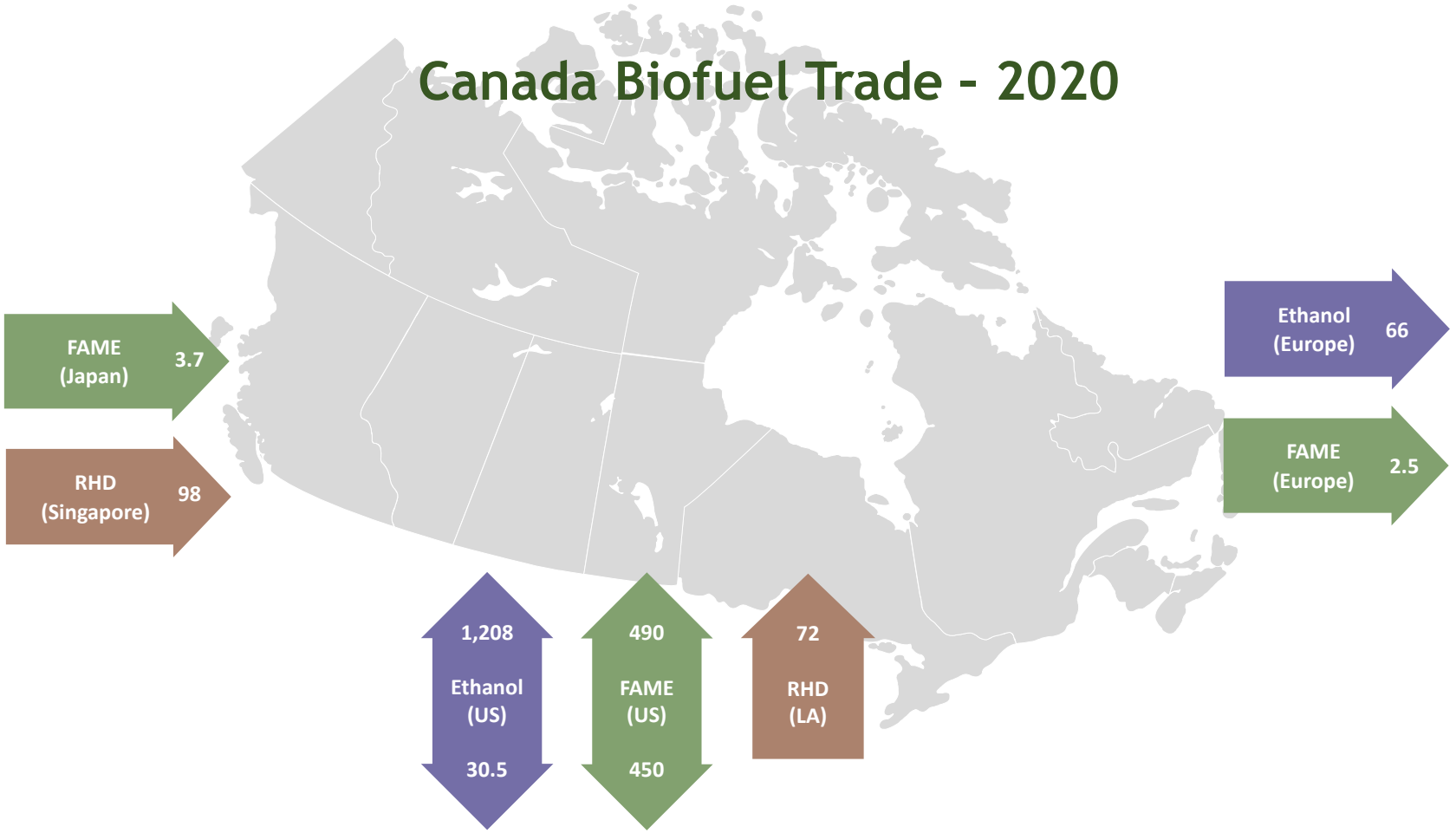


Oil Barrels/Day	Western Canada (BC, AB, SK, MB, west-ON)	Central Canada (Ontario, Quebec)
Demand Actual Market Use	808,000	923,000
Supply Maximum Refining Capacity	706,000	810,000
Fuel Deficit (barrels/day) Litres/year	102,000 **5,625,000,000**	113,000 **6,230,000,000**

Source: Capacity and demand data from Canadian Fuels Association, 2019

Source: NRCan, CFA

Canada Biofuel Trade - 2020



2020 Biofuel Trade (million litres)	Ethanol	FAME	RHD
Imports	1210	494	170
Exports	97	453	-

Source: Statistics Canada (totals may not sum due to rounding)

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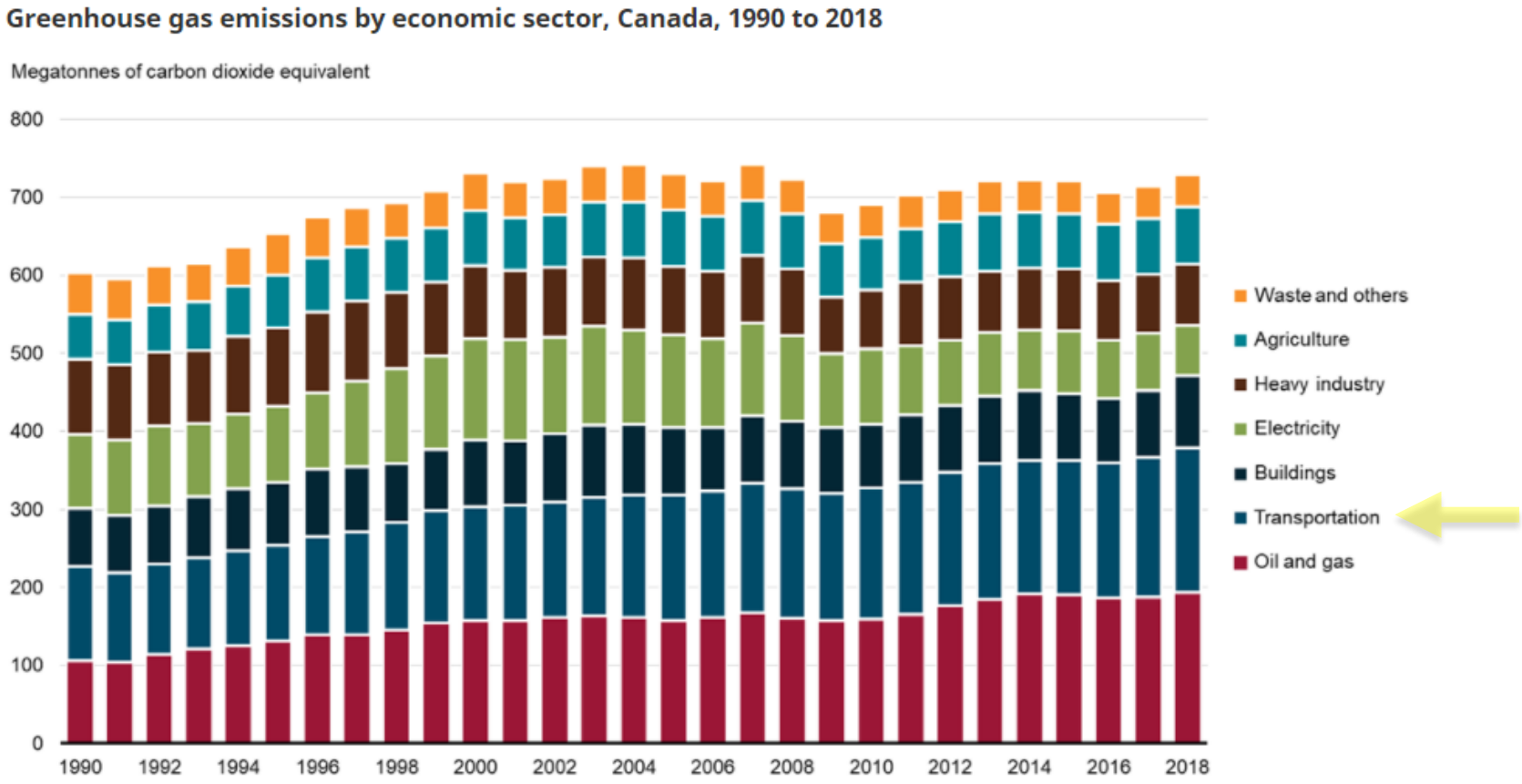
Canada's Greenhouse Gas Emissions



Source: ECCC

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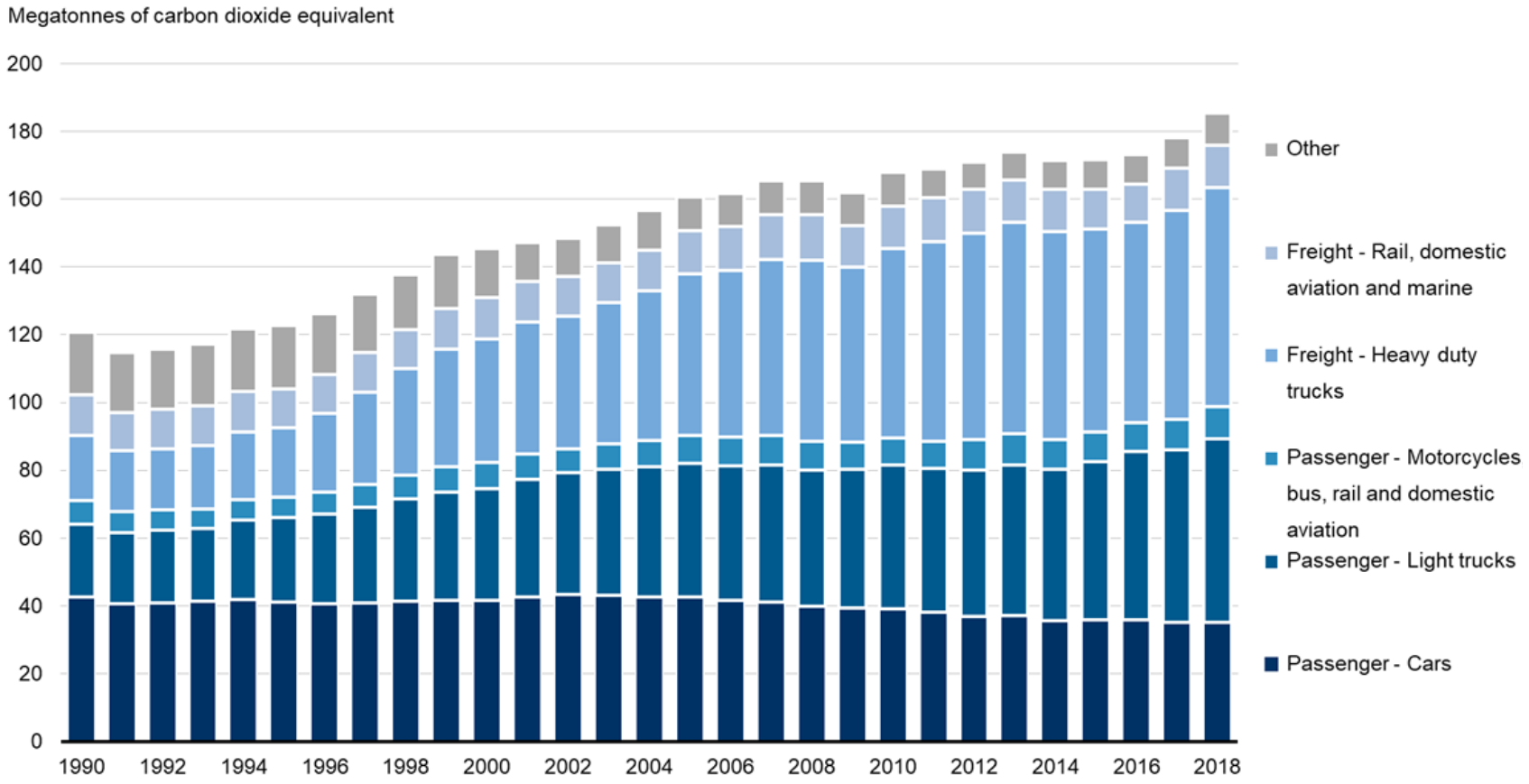
Transport Emissions — 1990 to 2018



Source: ECCC

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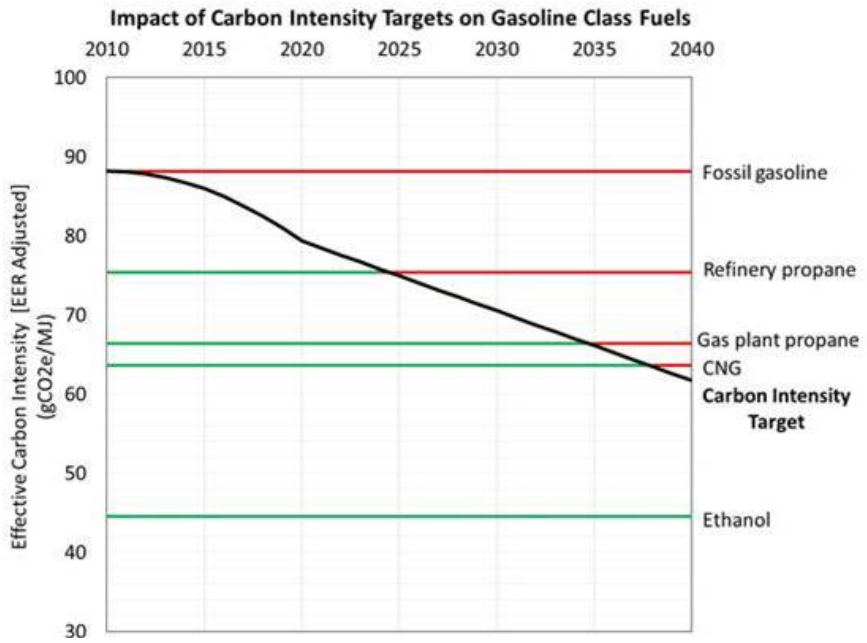
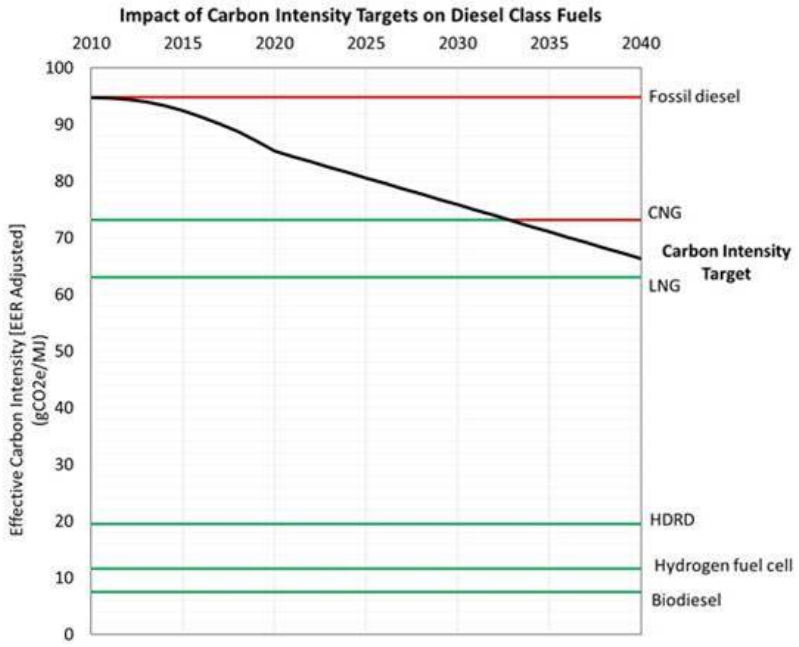
BC Low Carbon Fuel Standard

Gasoline Pool



Red – generates debits

Diesel Pool



Green – generates credits

Source: BC EMLI

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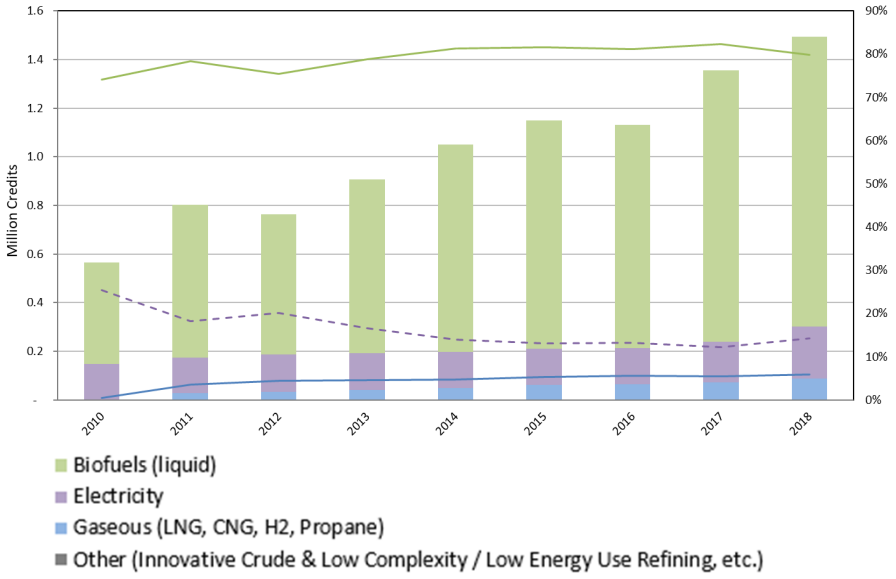
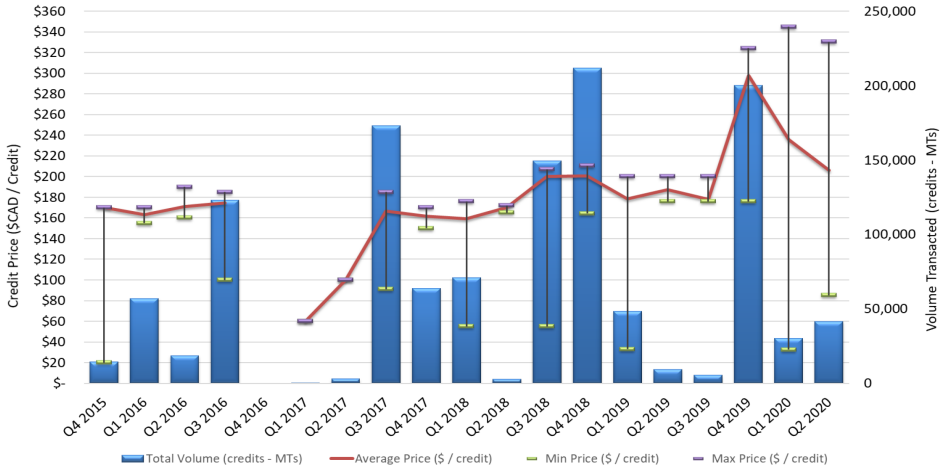
Biofuels in British Columbia LCFS – The First Decade

BC LCFS Credits and Proportion by Fuel Type (2010 – 2018)



BC LCFS Compliance Credit Trading (Q4 2015 – Q2 2020)



Source: ABFC; BC EMLI; Biofuels in Canada 2020, Navius Research (October 2020)

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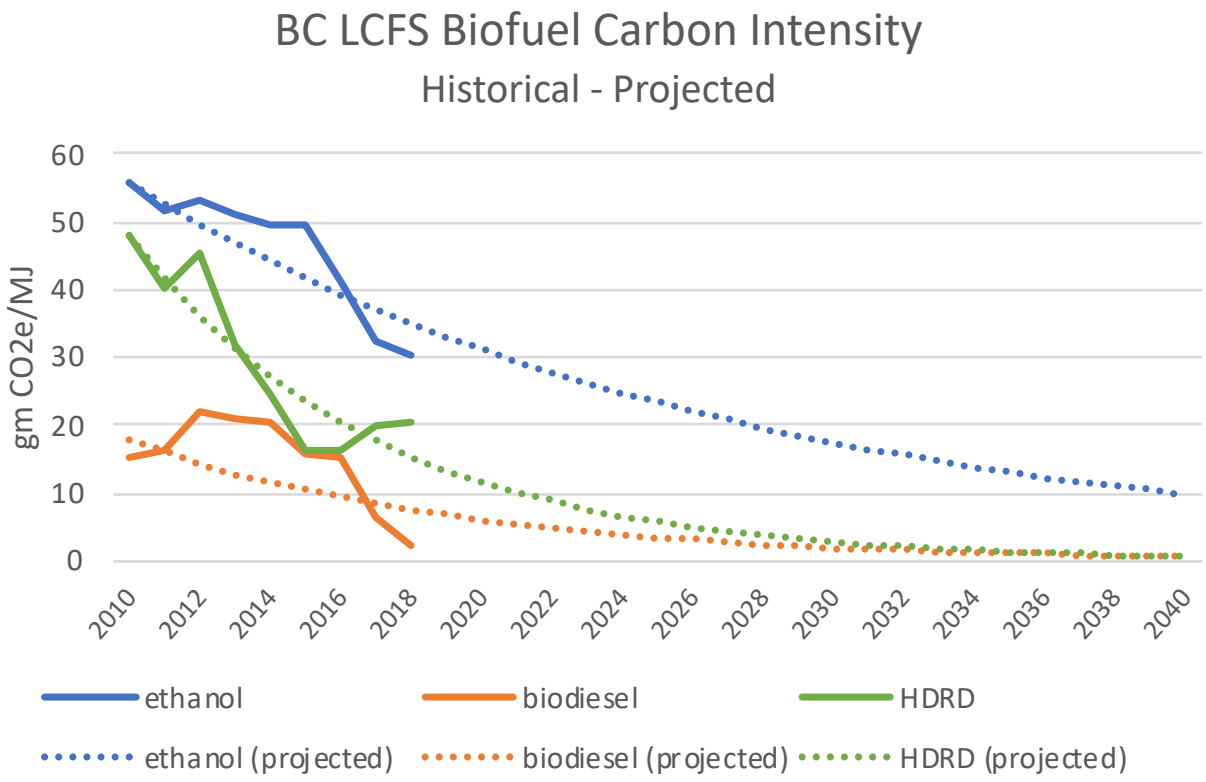
Low Carbon Fuel Standards Driving Innovation

2010-2018
Carbon Intensity Reduction

Ethanol
45%

Hydrogenation Derived
Renewable Diesel (HVO)
58%

Biodiesel
83%



Source: BC EMLI; ABFC

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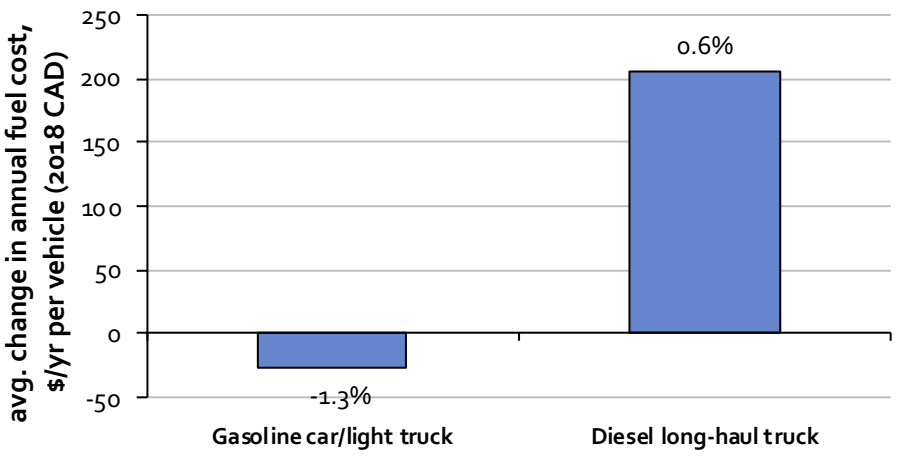
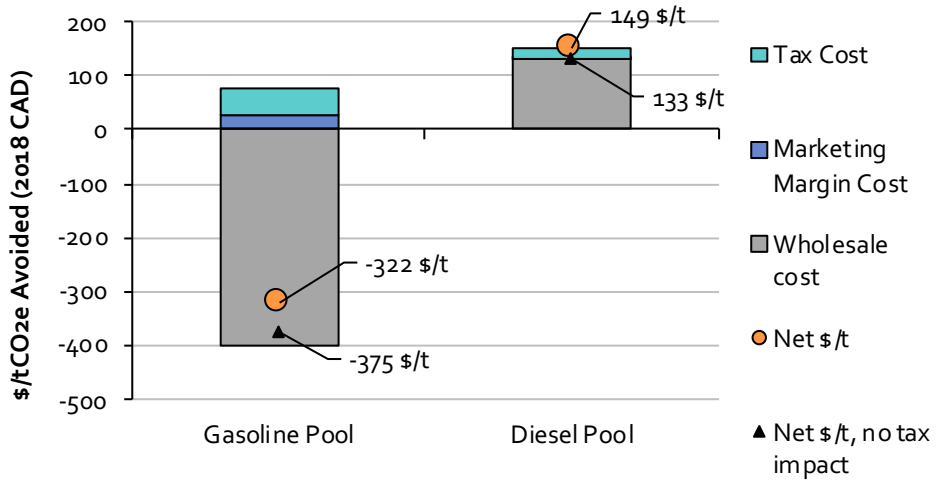
Biofuels as Cost Effective Mitigation: Canada 2010-2018

Archetypal User Impact





Source: Navius Research, *Biofuels in Canada 2020*

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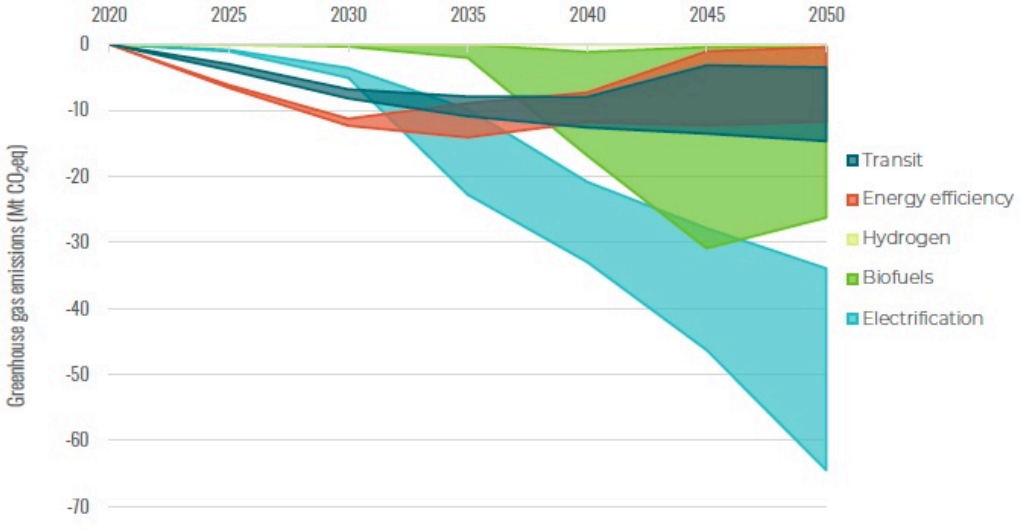
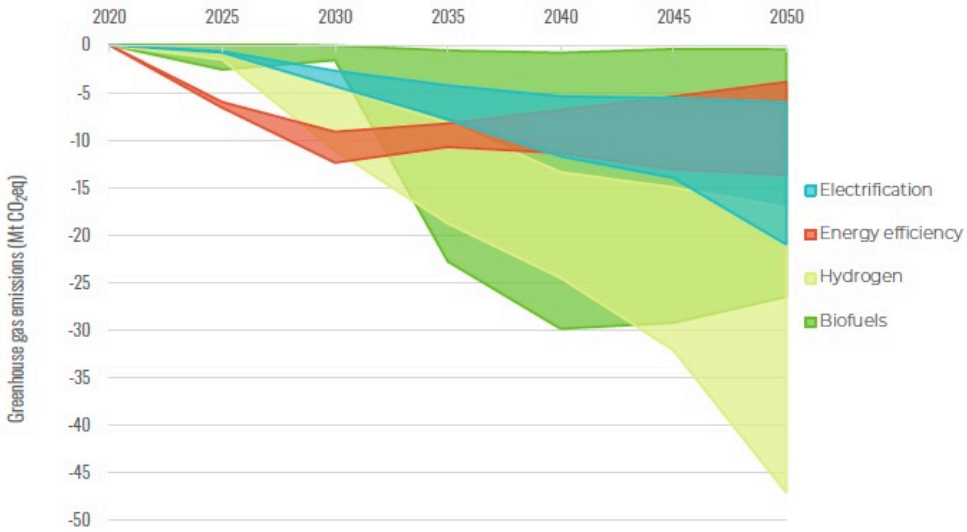
Net-Zero 2050 Transportation: GHG emissions reduction sources

Light-duty Vehicles



Medium- and Heavy-duty Vehicles



Source: Navius Research/CICC 2021

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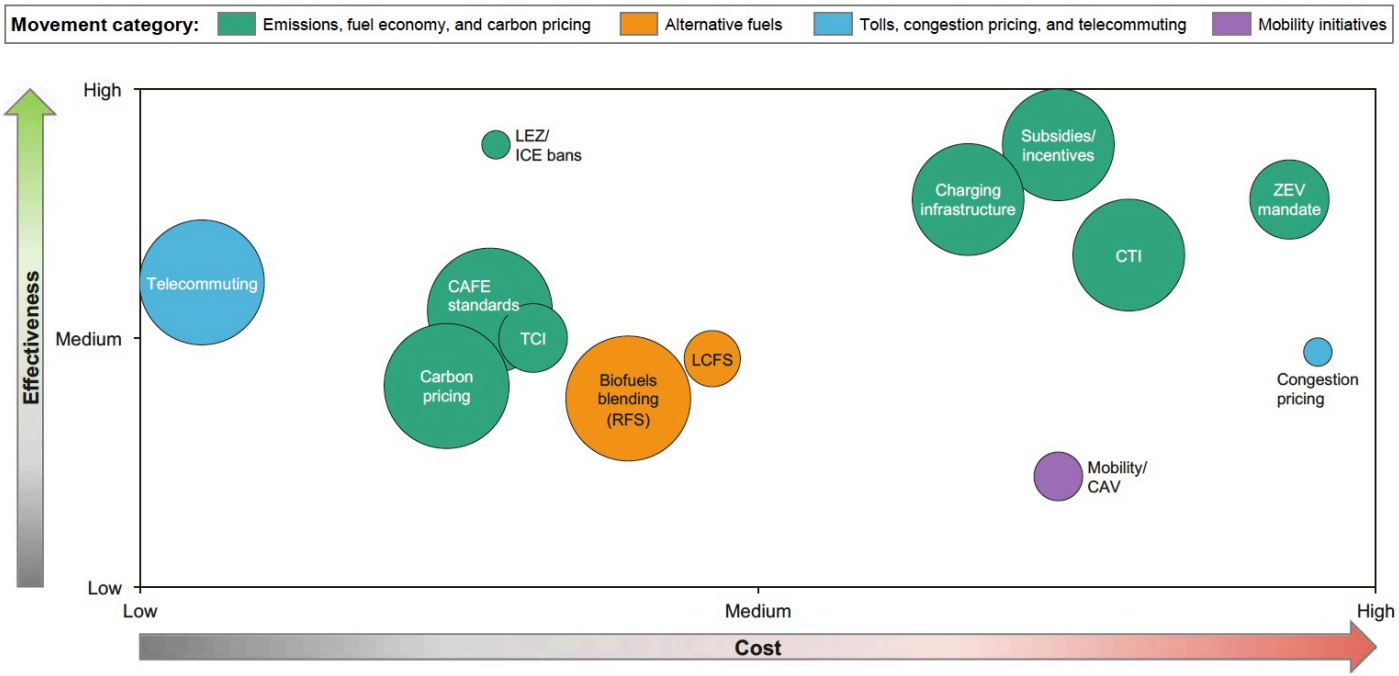
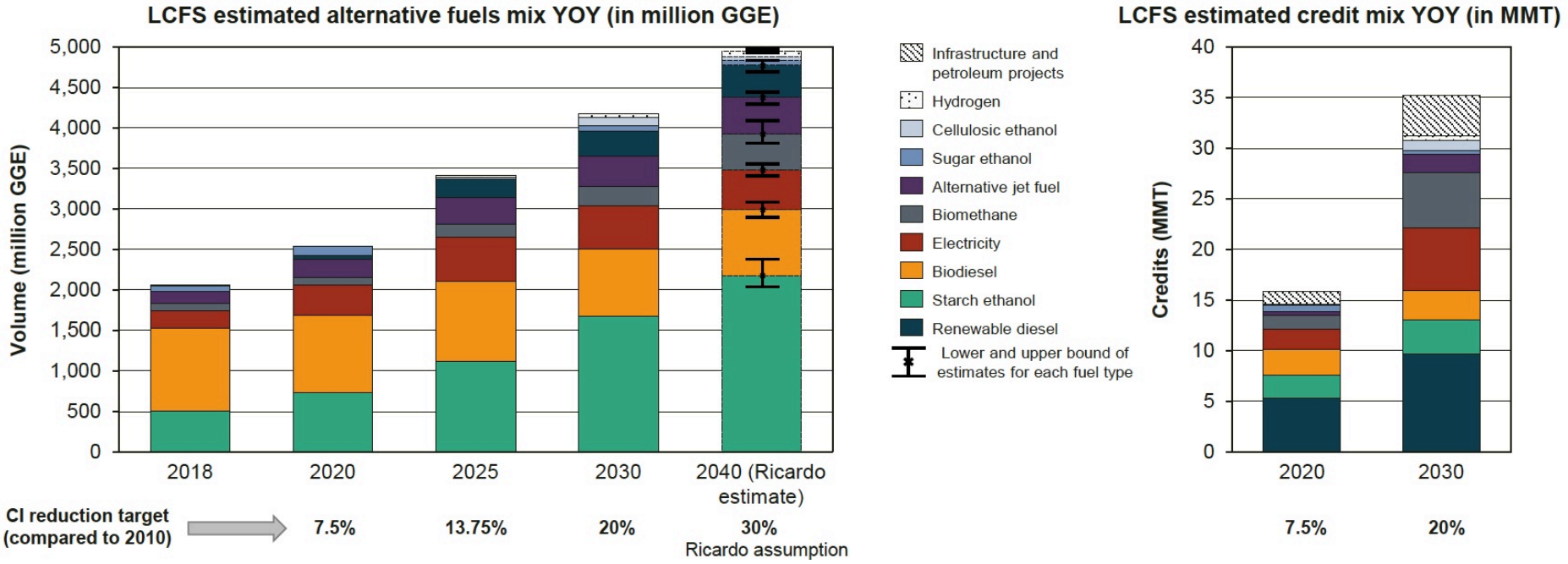
Impact of Transportation-Related Environmental Initiatives



Effectiveness: weighted average measure of emissions, fuel economy, and vehicle demand in terms of shift to alternative powertrains.
Cost: cost incurred by industry participants and/or consumers to comply with a movement.
Bubble size: whether the movement is nationwide, prevalent in some states, or limited to only a few regions or cities.

Source: Fuels Institute 2020, Ricardo

California LCFS – 2040 Scenarios



Source: Fuels Institute 2020 —CARB "Illustrative Compliance Scenario Calculator"; Ricardo analysis.

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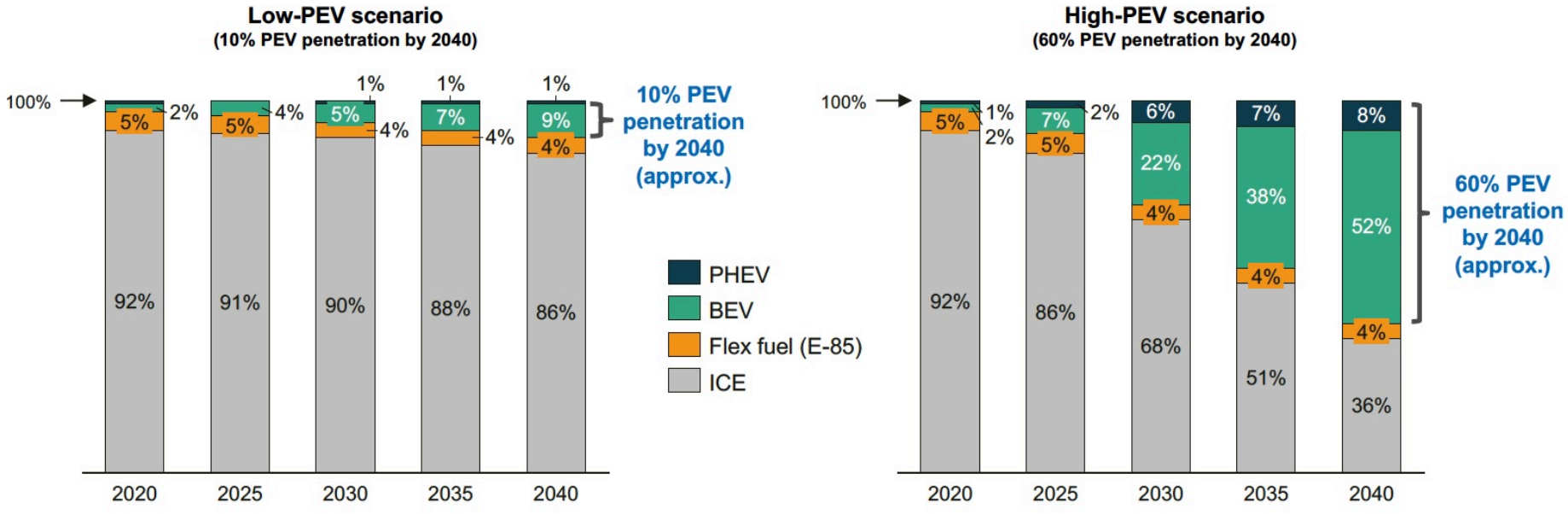
U.S. Light-duty Electric New Vehicle Sale Penetration Scenarios



Note: 16M vehicle sales per year considered from 2020 through 2040 (approx.)

Studies reviewed: AEO 2020 Outlook, BNEF 2019 EV Outlook, IEA 2019 Global EV Outlook, BCG Electric Car Tipping Point, Wood Mackenzie EV Outlook, UBS Auto and EV Outlook, Edison Electric Institute Electric Vehicle Trends, IHS Markit, etc.

Source: Fuels Institute 2020

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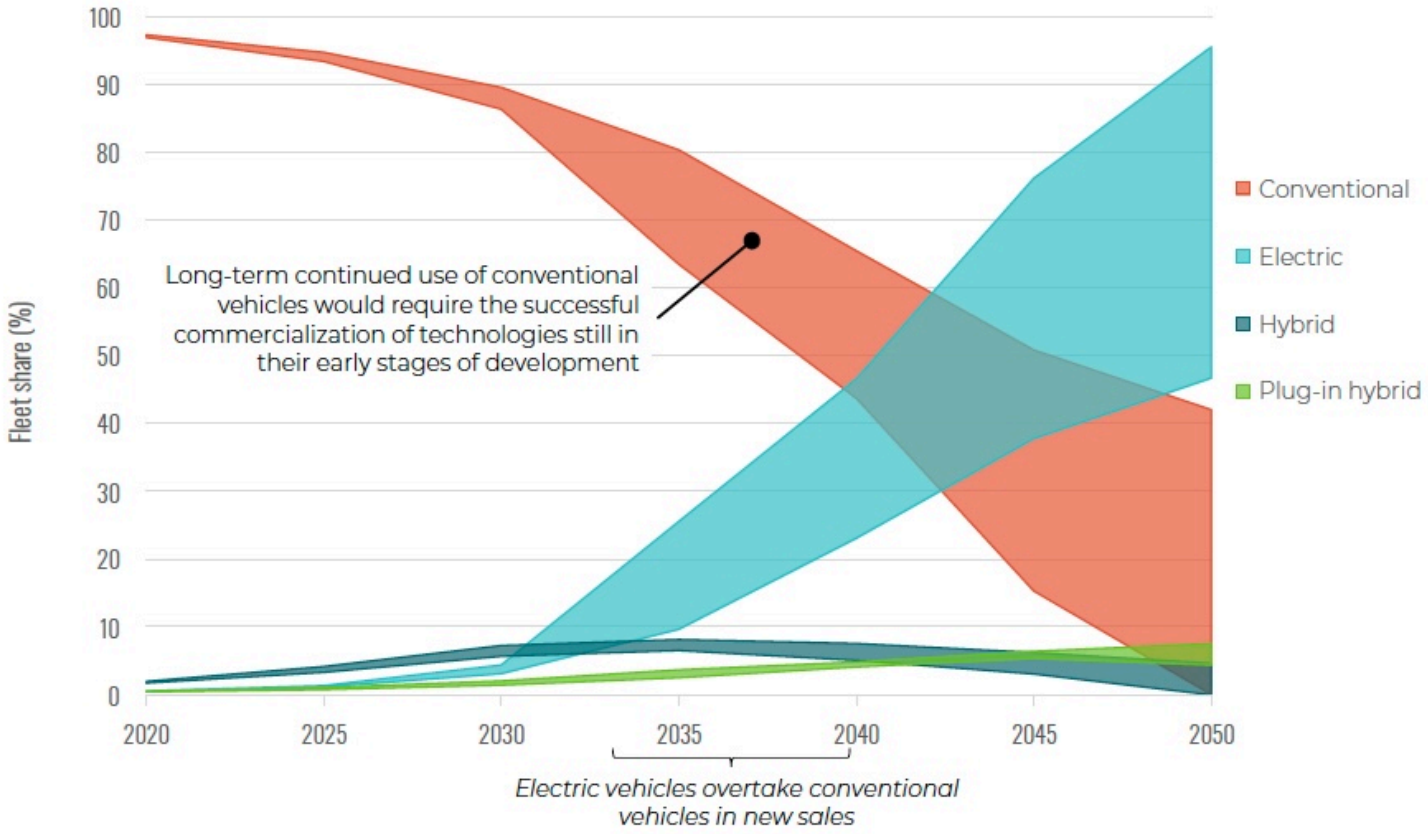
Market share, Light-duty vehicles - Canada 2050



Source: Navius Research/CICC 2021

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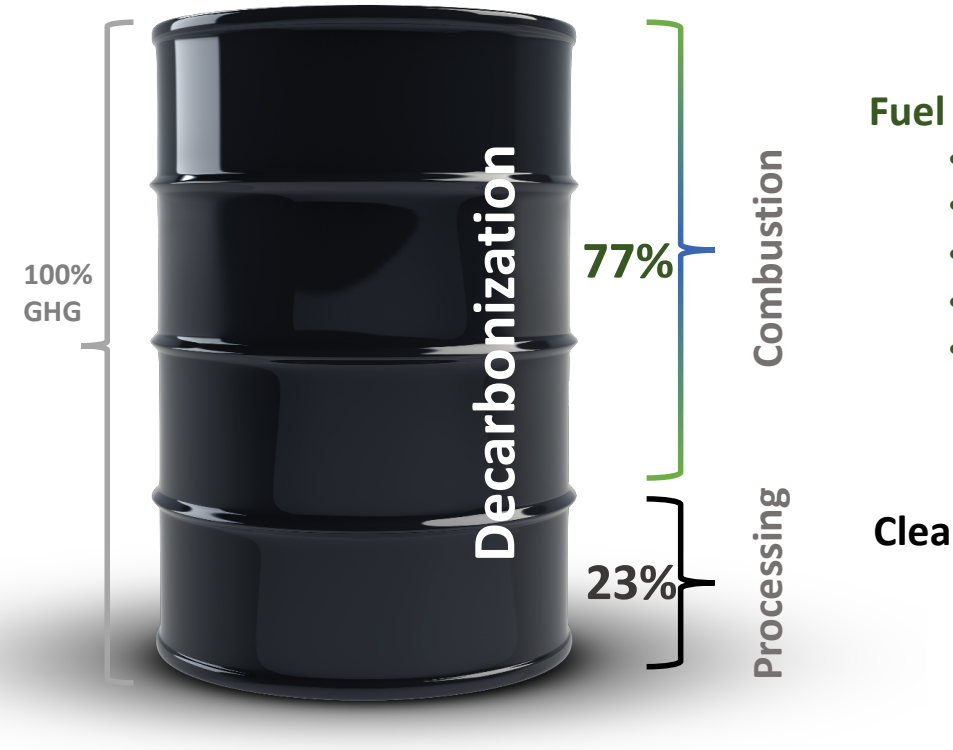
Canada's Energy & Climate Policy Imperatives:
Fork in the Road to NetZero 2050?

Transportation fuels: tailpipe combustion = 77% of full lifecycle GHG



REDUCTIONS

Fuel switching/displacement

- Biofuels
- Non-fossil synthetic fuels
- Renewable natural gas
- Electric vehicles
- Renewable hydrogen

¾ of Net-Zero 2050 targets

Cleaner Oil & Gas

- Carbon Capture & Storage
- Energy reduction technologies

Maximum reduction potential = ¼ of Well-to-Wheel emissions

Source: GHGenius (oilsands pathway), ABFC

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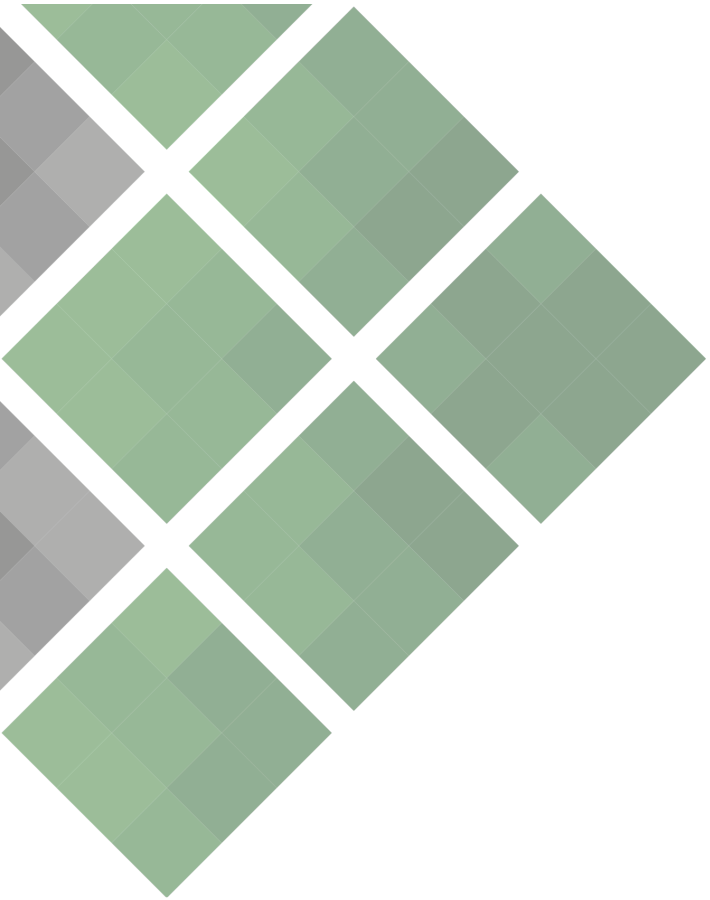

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