



Canada's Path to Paris Targets

*Forecasting Transportation GHG Emissions in
Canada for Period 2019 to 2030*

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INSTITUT C.D. HOWE INSTITUTE



*Executive Summary Showing
Results and Conclusions*

Conclusions of Forecast for Emissions from Transportation

- The model forecasts emissions from the various sub-sectors of transportation
- The Environment and Climate Change Canada (ECCC) released the Emissions Reduction Plan (ERP) in late March 2022
 - the ERP stated an emissions target in 2030 for transportation of 143 million tons (MT) of greenhouse gas (GHG) emissions
- The model forecasts emissions from transportation in 2030 as follows

	<u>2019</u>	<u>ERP 2030 Target</u>	<u>Model 2030 Forecast</u>
Cars	33	23	27
Light trucks	54	46	56
Freight trucks	66	41	61
Other	<u>33</u>	<u>33</u>	<u>33</u>
Total	186	143	177

- The conclusion from the model is that 2030 emissions from transportation will exceed the 2030 target in the Emissions Reduction Plan by 34 MT

Conclusions of Forecast for Emissions from Transportation

Reasons why Model Forecasts ERP 2030 Target for GHG Emissions will Not be Met

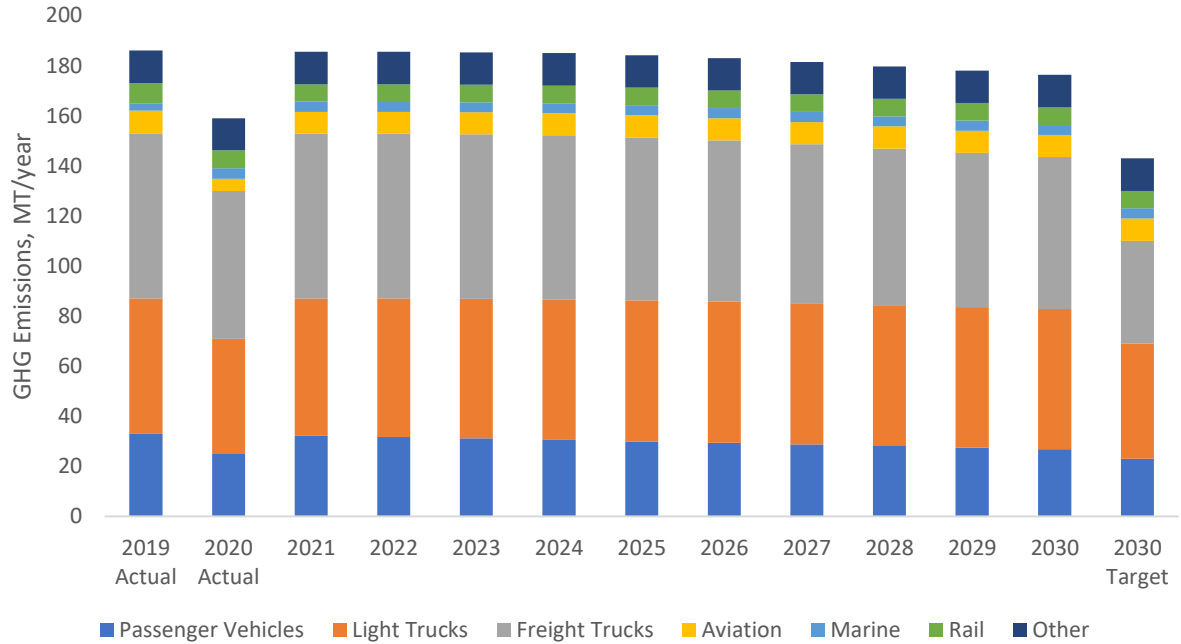
- The major tool to lower emissions is to replace vehicles using hydrocarbon fuels with electric vehicles
- The model concludes that
 - the supply of electric vehicles will be an issue due to the need to construct and ramp up manufacturing capacity
 - even assuming a dramatic increase in the supply of electric vehicles, the large current fleet of vehicles will still be mostly gasoline and diesel in 2030
- Numbers of vehicles in 2030, millions

	<u>Electric</u>	<u>Gasoline and Diesel</u>
Passenger Cars	1.0	10.8
Light Trucks	1.0	11.5
Freight Trucks	0.1	1.1

Final Summary of Transportation Emissions for Period 2019 to 2030



Transportation Emissions, MT/year



- Forecast emissions for 2030 of 177 MT exceeds 2030 target of 143 MT by 34 MT

Methodology of Model

Methodology of Model Used to Forecast Emissions of the Transportation Sector

- Model starts with data from Government of Canada documents
 - Emissions Reduction Plan (ERP) dated March 29 2022 from ECCC
 - National Inventory Report dated April 14 2022
 - Various NRCan websites
- These documents are used to set the 2019 emissions and the 2030 target for emissions for the seven subsectors that comprise the transportation sector
 - Vehicles
 - Passenger cars
 - Light trucks
 - Freight trucks
 - Aviation
 - Marine
 - Rail
 - Other
- Model then makes assumptions for the period 2019 to 2030 and allocates emissions to these seven subsectors

Key Aspects of Model

- Emissions numbers indicate that since largest numbers are from emissions for vehicles, largest amount of reductions will come from vehicles

Key Variables

- Number of vehicles in fleet
 - passenger cars
 - light trucks
 - freight trucks
- Sales of internal combustion engine vehicles and electric vehicles
- Rate of increase in EV sales
- Assessment of supply of EV vehicles, both domestic Canadian and imports
- Emissions per vehicle in 2019
- Rate of making renewable ICE fuel such as ethanol, biodiesel and sustainable aviation fuel (SAF)
- Improvement in emissions for ICE vehicles due to biofuels
- Rate of retirement of ICE vehicles

Methodology of Model Used to Forecast Emissions of the Transportation Sector

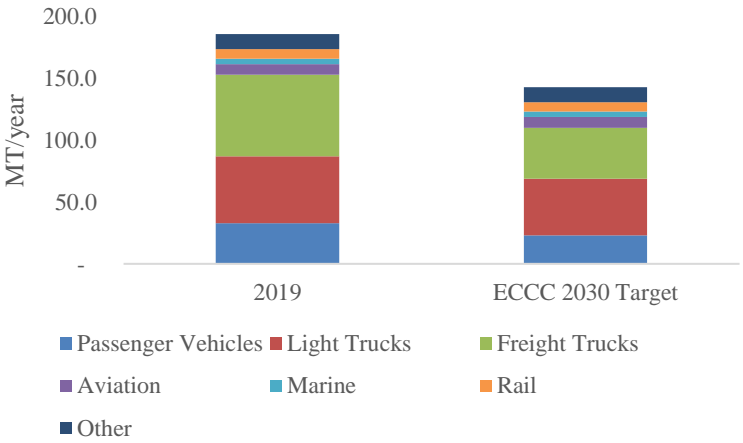
- The final result is a forecast of the total emissions of the entire transportation sector for each year from 2019 to 2030, broken down by each of the seven sub sectors

*Summary of 2019 Emissions and 2030
Targets for Transportation in Canada*

Summary of ECCC 2030 Target Emission Reductions for All Sub Sectors

- ECCC 2030 Target of 143 MT assumes 43 MT reduction from the 2019 Emissions of 186 MT
- The numbers shown below are a reasonable allocation amongst these sub sectors of this 43 MT reduction
- Greatest reductions are for passenger cars, light trucks and freight trucks

2019 Emissions Versus ECCC 2030 Target Emissions, by Sub Sector



Passenger cars	-10.0
Light trucks	-8.0
Freight trucks	-25.0
Aviation	0.4
Marine	-0.2
Rail	0.0
Other	<u>-0.2</u>
Total	-43.0

Summary of Forecast for Meeting Emissions Targets for Transportation

Transportation Emissions, MT

<u>Sub Sector</u>	<u>2019</u>	<u>ECCC 2030 Target</u>
Passenger Cars	33	23
Light Trucks	54	46
Freight Trucks	66	41
Aviation	9	9
Marine	4	4
Rail	8	8
Other	<u>12</u>	<u>12</u>
Total	186	143

Notes:

1. 2019 emissions are from April 14 2022 National Inventory Report
2. ECCC 2030 Target emissions assume only reduction is in passenger cars, light trucks and freight trucks

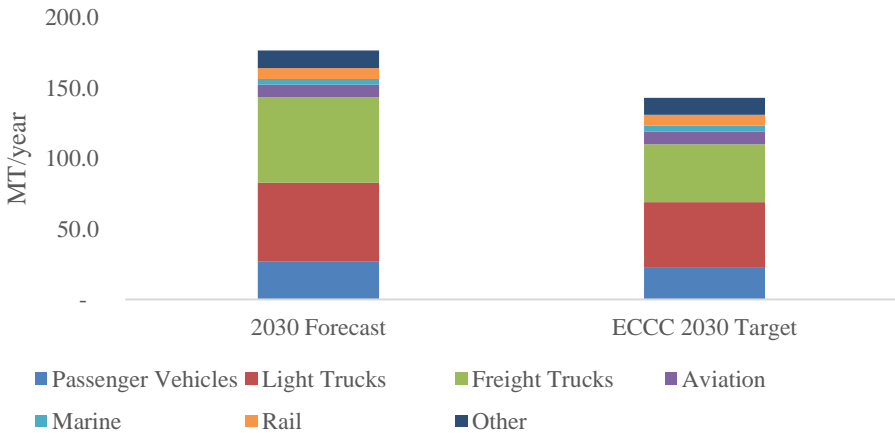
*Summary of Emissions Reductions
Forecasted by Model*

Summary of Total Emission Reductions by 2030 for All Sub Sectors



- Forecast from model shows total emissions in 2030 of 177 MT versus ECCC 2030 target of 143 MT, a shortfall of 34 MT
- Main shortfall occurs in passenger cars, light trucks and freight trucks

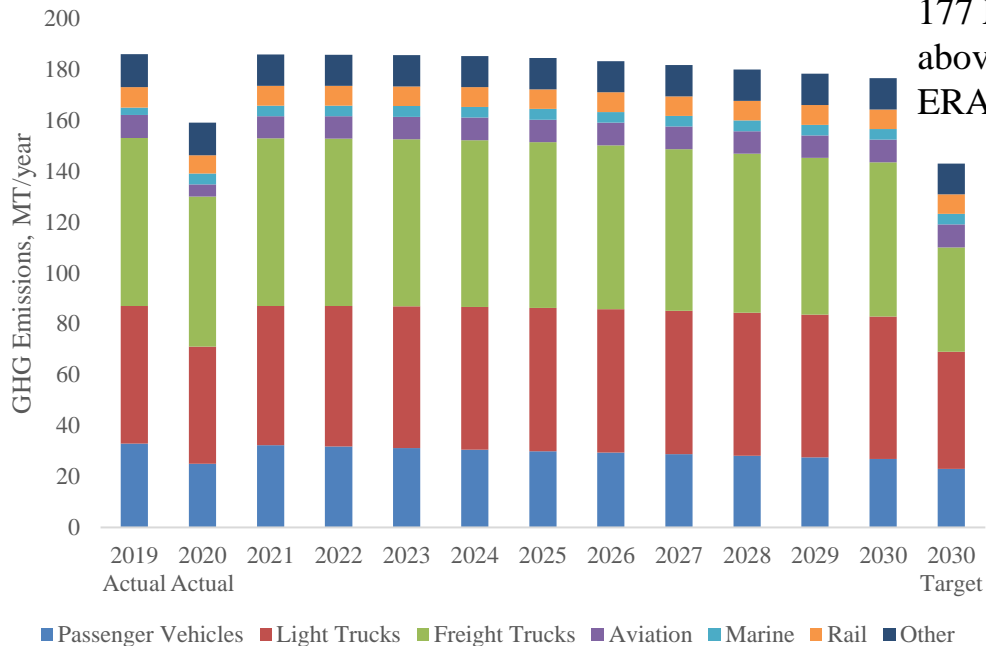
2030 Forecast Versus ECCC 2030 Target



Passenger cars	-4.0
Light trucks	-10.0
Freight trucks	-20.0
Aviation	0.1
Marine	0.0
Rail	0.0
Other	<u>-0.1</u>
Total	-34.0

Forecast of Transportation Emissions for Period 2020 to 2030

Transportation Emissions, MT/year



Emissions of 186 MT in 2019 are forecast to drop to 177 MT in 2030, or 34 MT above the 143 MT ECCC ERA target.

*Summary of Various Methods of
Reducing Emissions Used by Model*

Key Variables and Methods to Reduce Emissions

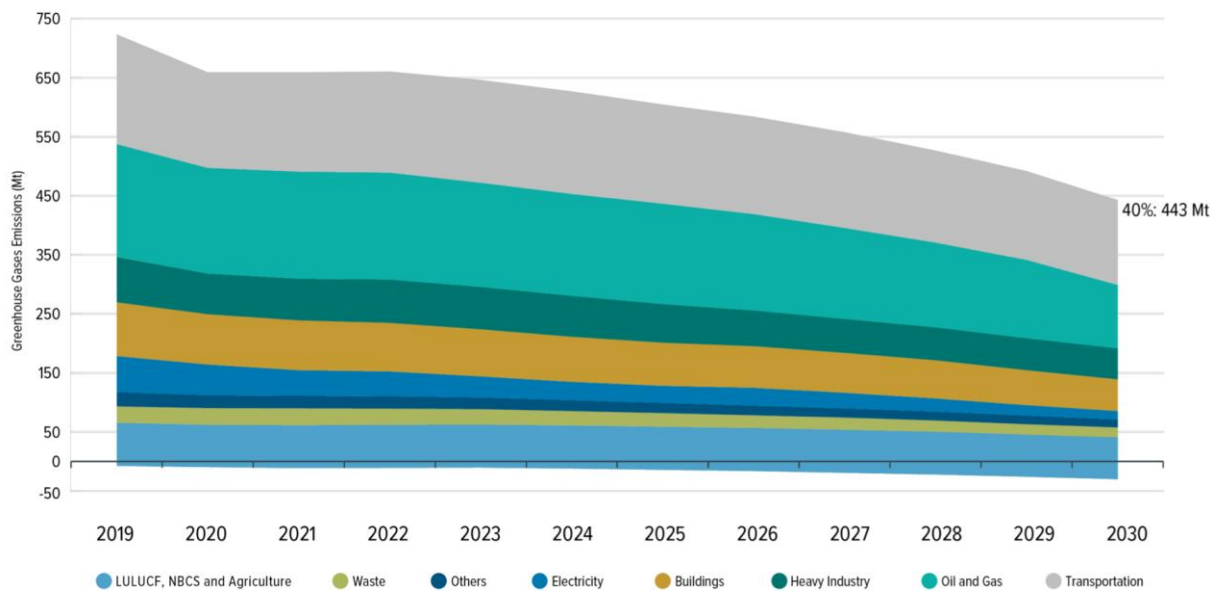
- Increase sales of electric vehicles
 - Passenger cars
 - Light trucks
 - Freight trucks
- Increase use of renewable fuels
 - Ethanol
 - Biodiesel
 - Sustainable aviation fuel (SAF)

*Appendix: Detailed Material on Data
Generated by Model*

*Summary of Emissions for
Transportation Sector for 2019 to 2030*

ECCC March 29 2022 ERP Showing Future Targets for Emissions in Canada

Pathway to 2030



March 29 2022 ECCC release shows transportation target reduction for 2030 of 43 MT (reduction from 186 MT in 2019 to 143 MT in 2030, a drop of 23%).

Summary of Forecast for Meeting Emissions Targets for Transportation

Transportation Emissions, MT

	<u>2019</u>	<u>ECCC 2030 Target</u>
Passenger Cars	33	23
Light Trucks	54	46
Freight Trucks	66	41
Aviation	9	9
Marine	3	3
Rail	8	8
Other	<u>13</u>	<u>13</u>
Total	186	143

Notes:

1. 2019 emissions are from April 14 2022 National Inventory Report
2. ECCC 2030 Target emissions assume only reduction is in passenger cars, light trucks and freight trucks

*Historical Emissions for Transportation
Sector for 2020 to 2030*

Emissions for Transportation sector in National Inventory Reports April 14 2022

Table 2-5 **GHG Emissions from Transport, Selected Years**

CRF Code		GHG Emissions (Mt CO ₂ eq)								Change (%)	
		1990	2005	2015	2016	2017	2018	2019	2020	1990-2020	2005-2020
1.A.3	Transport	145	190	201	200	208	215	216	190	31%	0%
	Aviation	7.5	7.7	7.6	7.5	7.9	8.7	8.6	4.8	-36%	-38%
1.A.3.a	Domestic Aviation (Civil)	7.3	7.5	7.4	7.3	7.7	8.4	8.3	4.6	-37%	-38%
1.A.5.b	Military	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.2	-20%	-28%
	Road Transportation	84	130	142	145	148	152	153	131	57%	1%
1.A.3.b.i	Light-Duty Gasoline Vehicles	42	41	34	35	34	33	32	25	-40%	-40%
1.A.3.b.ii	Light-Duty Gasoline Trucks	20	38	45	48	49	51	53	45	124%	19%
1.A.3.b.iii	Heavy-Duty Gasoline Vehicles	6.3	12	12	13	13	13	14	13	100%	8%
1.A.3.b.iv	Motorcycles	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.2	171%	20%
1.A.3.b.i	Light-Duty Diesel Vehicles	0.5	0.6	0.9	0.8	0.8	0.8	0.8	0.5	5%	-19%
1.A.3.b.ii	Light-Duty Diesel Trucks	0.2	0.3	0.8	0.9	1.1	1.2	1.2	1.0	547%	187%
1.A.3.b.iii	Heavy-Duty Diesel Vehicles	14	37	48	47	49	52	52	46	240%	26%
1.A.3.b.v	Propane and Natural Gas Vehicles	1.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	-100%	-99%
1.A.3.c	Railways	6.9	6.6	7.1	6.5	7.5	7.6	7.7	7.2	4%	9%
	Marine	3.1	4.0	3.4	3.5	3.6	3.8	4.4	4.2	36%	5%
1.A.3.d	Domestic Navigation	2.2	3.1	3.1	3.2	3.4	3.6	4.1	3.8	77%	25%
1.A.4.c.iii	Fishing	0.9	0.9	0.2	0.2	0.2	0.2	0.2	0.2	-73%	-73%
1.A.5.b	Military Water-Borne Navigation	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.1	283%	303%
	Other Transportation	44	42	41	38	41	43	43	43	-2%	2%
1.A.4.c.ii	Off-Road Agriculture and Forestry	9.0	11	10	9.7	10	11	11	12	29%	2%
1.A.4.a.ii	Off-Road Commercial and Institutional	1.5	2.4	2.7	2.6	2.8	2.9	3.0	2.9	89%	20%
1.A.2.g.vii	Off-Road Manufacturing, Mining and Construction	9.2	10	13	12	14	14	14	14	54%	36%
1.A.4.b.ii	Off-Road Residential	0.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	411%	-2%
1.A.3.e.ii	Off-Road Other Transportation	17	6.4	4.8	4.9	5.1	5.3	5.0	5.0	-70%	-22%
1.A.3.e.i	Pipeline Transport	6.9	10	8.3	7.7	7.6	8.4	8.5	7.7	12%	-23%

Source: ECCC National Inventory Report 1990 – 2020 dated April 14 2022

Historical Emissions from the Transportation Sector in Canada

	2005	2014	2015	2016	2017	2018	2019
Mt CO ₂ equivalent							
National GHG Total	739	723	723	707	716	728	730
Oil and gas	160	190	190	181	183	191	191
Electricity	118	76	79	74	72	62	61
Transport	160	171	172	174	179	184	186
Heavy Industry ^a	87	79	77	76	75	77	77
Buildings	84	85	83	81	86	90	91
Agriculture ^b	72	71	71	72	71	73	73
Waste and Others ^c	57	50	50	50	50	51	51

Notes:

Totals may not add up due to rounding.

Estimates presented here are under continuous improvement. Historical emissions may be changed in future publications as new data becomes available and methods and models are refined and improved.

a. Heavy industry represents emissions arising from non-coal, -oil and -gas mining activities, smelting and refining, and the production and processing of industrial goods such as fertilizer, paper or cement.

b. Emissions associated with the production of fertilizer are reported in the Heavy Industry sector.

c. "Others" includes Coal Production, Light Manufacturing, Construction and Forest Resources.

Source: 2021 National Inventory Report

- Emissions from transportation rose from 160 MT in 2005 to 186 MT in 2019

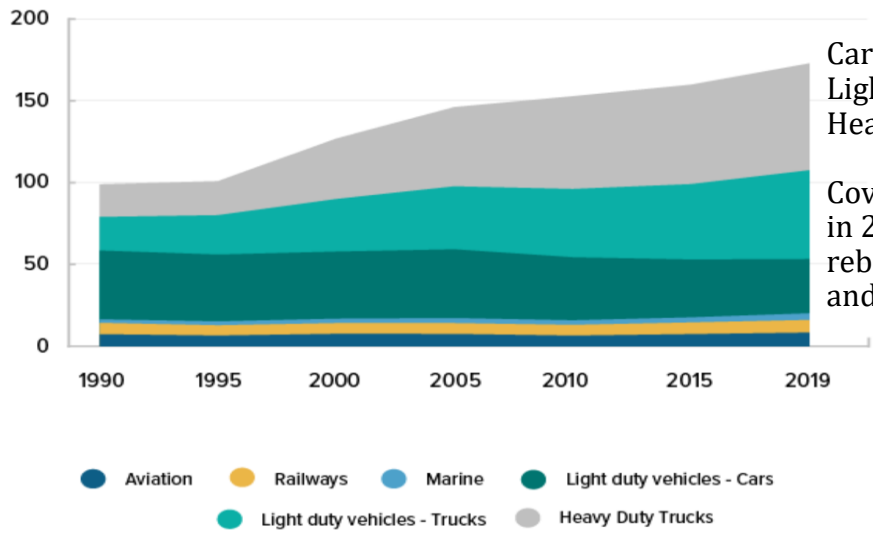
Historical Emissions from Various Parts of the Transportation Sector in Canada



CANADA'S TRANSPORTATION

Historical Transportation Emissions for Selected Modes

March 29 2022 ECCC release shows for 2019



	2019	2020
Cars	33MT	26 MT
Light trucks	54MT	46 MT
Heavy duty trucks.	66MT	59 MT

Covid pandemic reduced emissions in 2020 significantly, but likely rebounded to 2019 levels in 2021 and 2022.

March 29 2022 ECCC release shows over 60% of emissions come from light trucks and freight. These two components have increased massively since 1990. Emissions from cars have decreased since 1990, and emissions from aviation, rail and marine have remained flat.

*Model to Forecast Emissions from
Transportation Sector in 2022 to 2030*

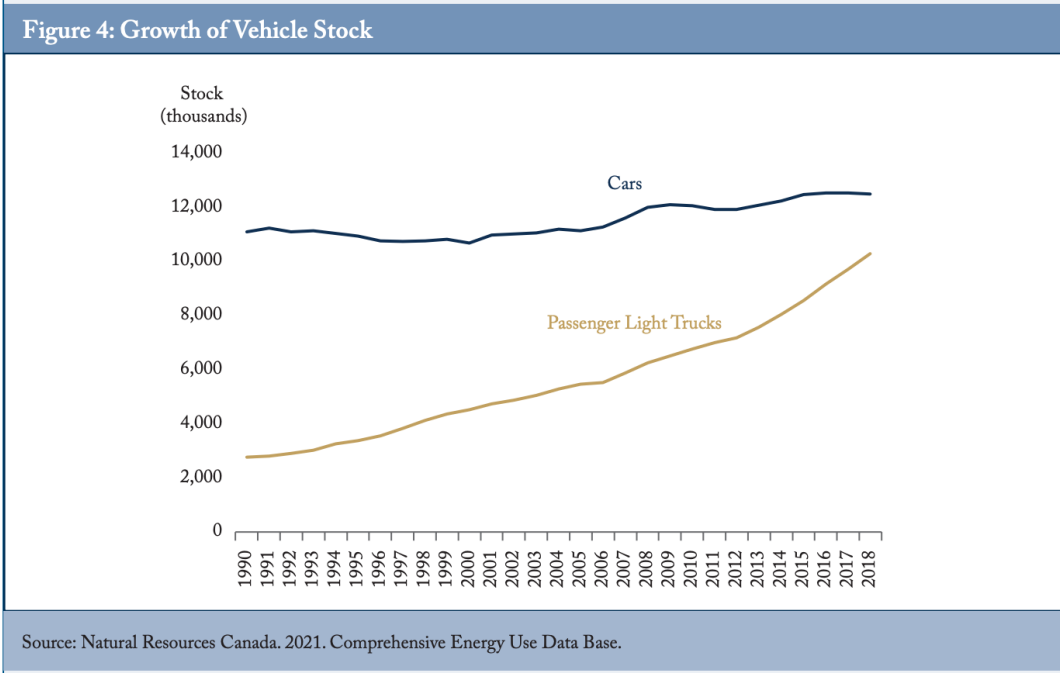
Key Aspects of Model

- Emissions numbers indicate that since largest numbers are from emissions for vehicles, largest amount of reductions will come from vehicles

Key Variables

- Number of vehicles in fleet
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- Sales of internal combustion engine vehicles and electric vehicles
- Rate of increase in EV sales
- Assessment of supply of EV vehicles, both domestic Canadian and imports
- Emissions per vehicle in 2019
- Rate of making renewable ICE fuel such as ethanol, biodiesel and sustainable aviation fuel (SAF)
- Improvement in emissions for ICE vehicles due to biofuels
- Rate of retirement of ICE vehicles

Current Fleet Size of Vehicles in Canada



Car numbers have remained flat in the past 30 years, yet total emissions have decreased. Truck numbers have increased by 4 times since 1990, yet total emissions only doubled. This improvement in emissions intensity is due in large part to more efficient engines plus the use of the renewable fuel ethanol in gasoline.

30 Source: https://www.cdhowe.org/sites/default/files/attachments/research_papers/mixed/Commentary_604.pdf

Total Registration of Fleet of Vehicles in Canada in 2019



Geography	Canada (map)
Type of vehicle	2019
	Number
Total, vehicle registrations	35,742,412
Total, road motor vehicle registrations	25,422,635
Vehicles weighing less than 4,500 kilograms	23,472,111
Vehicles weighing 4,500 kilograms to 14,999 kilograms	633,663
Vehicles weighing 15,000 kilograms or more	488,902
Buses	91,743
Motorcycles and mopeds	736,216
Trailers	7,933,361
Off-road, construction, farm vehicles	2,386,416

Source: <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2310006701&pickMembers%5B0%5D=1.1&cubeTimeFrame.startYear=2019&cubeTimeFrame.endYear=2019&referencePeriods=20190101%2C20190101>

*Current Emissions of Vehicles
in Canada per Vehicle*

Passenger Cars and Light Trucks in Canada



Passenger Cars



F150 Lightning Truck

- Statistics Canada reports that there are about 12.1 million passenger cars and 10 million light trucks (including SUVs and crossover vehicles) in Canada in 2020
- Dividing 33 MT of GHG emissions by 12.1 million gives emissions of about 2.7 tonnes per passenger car
- Dividing 54 MT of GHG emissions by 10 million gives emissions of about 5.4 tonnes per light truck



Light Class 2 to 4 Trucks



Medium Class 5 to 7 Trucks



Heavy Class 8 Trucks

- Statistics Canada Reports that there are about 1.1 million Freight Trucks in Canada
- Dividing 66 MT of GHG emissions by this number gives emissions of about 58.6 MT per truck

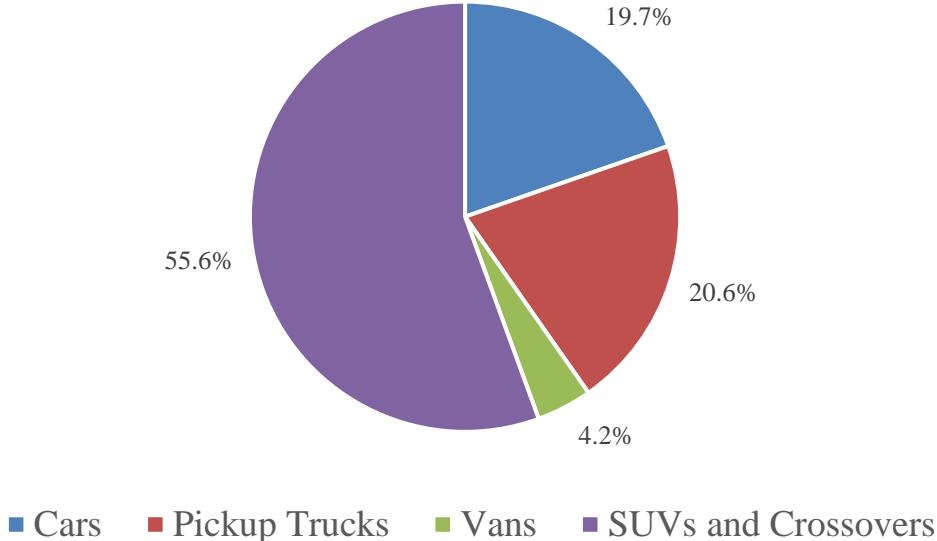
*Current Annual Sales of Vehicles in
Canada*

Total Registration of Sales of Vehicles in Canada in 2021 and Q1 2022

Geography	Canada (map)				
Vehicle type	Total, vehicle type ¹				
Statistics	Number of vehicles				
Fuel type	Q1 2021	Q2 2021	Q3 2021	Q4 2021	Q1 2022
	Units				
All fuel types	375,826	486,592	446,620	337,571	339,820
Gasoline	326,146	416,441	384,338	288,436	282,993
Diesel	18,112	20,057	14,411	13,301	15,982
Battery electric	12,693	16,167	15,845	14,021	19,695
Hybrid electric	14,278	26,088	23,909	15,055	14,826
Plug-in hybrid electric	4,592	7,839	8,117	6,758	6,323
Other fuel types ²	5	0	0	0	1

Source: <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002401>

Sale of Vehicles in 2021 by Type of Vehicle



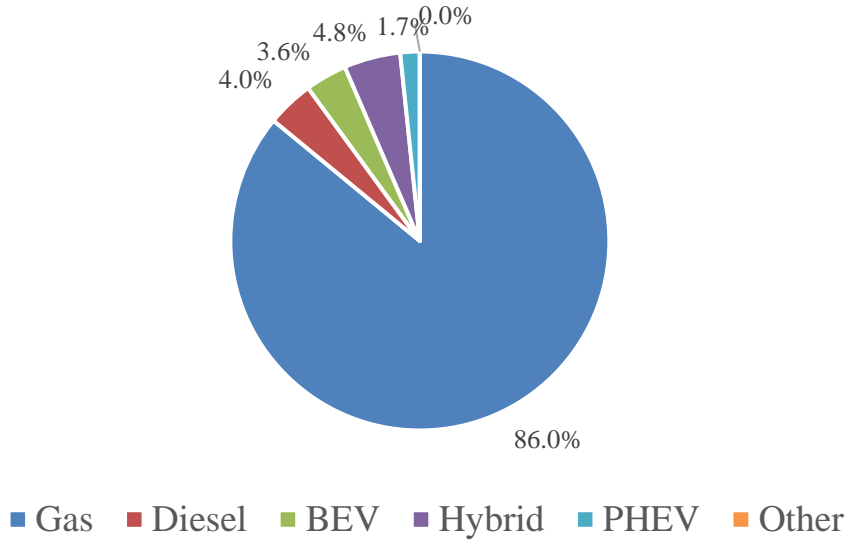
Total passenger vehicle sales in Canada in 2021 were 1.65 million, down from pre pandemic sales of 1.9 million in 2019

Source: Statistics Canada

Sales Mix of Passenger Vehicles In Canada by Fuel

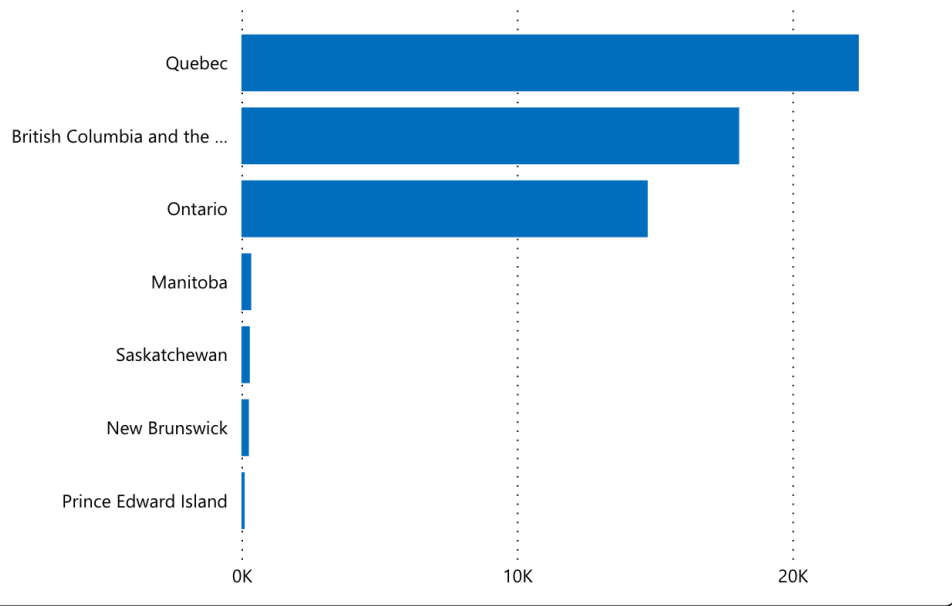


Sale of Vehicles in 2021 by Fuel



Battery Electric Vehicle (BEV) sales were 3.6% of all passenger vehicles, but were 8.7% of cars (19.7% of sales) and 3.4% of SUVs and crossovers (55% of sales). Pickup trucks and vans had no BEV sales. There were significant hybrid and PHEV in cars and SUVs and crossovers, with smaller numbers of pickup trucks and vans.

New motor vehicles registered by province, BEV

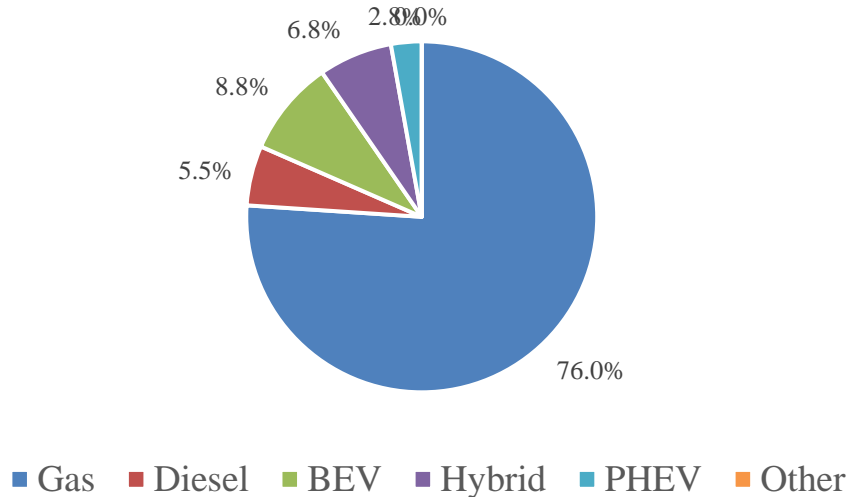


BEV sales in 2021 were concentrated in Quebec and British Columbia, who have both incentive payments for purchasers as well as ZEV mandates for sellers.

Sales Mix of Passenger Vehicles In British Columbia by Fuel



Sale of Vehicles in B.C. in 2021 by Fuel



Battery Electric Vehicle (BEV) sales were 8.8% of all passenger vehicles, the highest number for any province, and were 20% of cars (9,000 out of 45,000) and 8.5% of SUVs and crossovers (9,000 out of 110,00). Pickup trucks and vans had no BEV sales.

Source: Statistics Canada

*Model for Determining Transportation
Emissions in 2030*

- Rate of sales of Electric Vehicles to replace internal combustion engine (ICE) vehicles
 - passenger cars
 - light trucks, SUVs and crossover vehicles
 - freight trucks
- Use of renewable fuels to lower emissions of ICE vehicles

*Forecast of Annual Sales of Electric
Vehicles in Canada from 2021 to 2030*

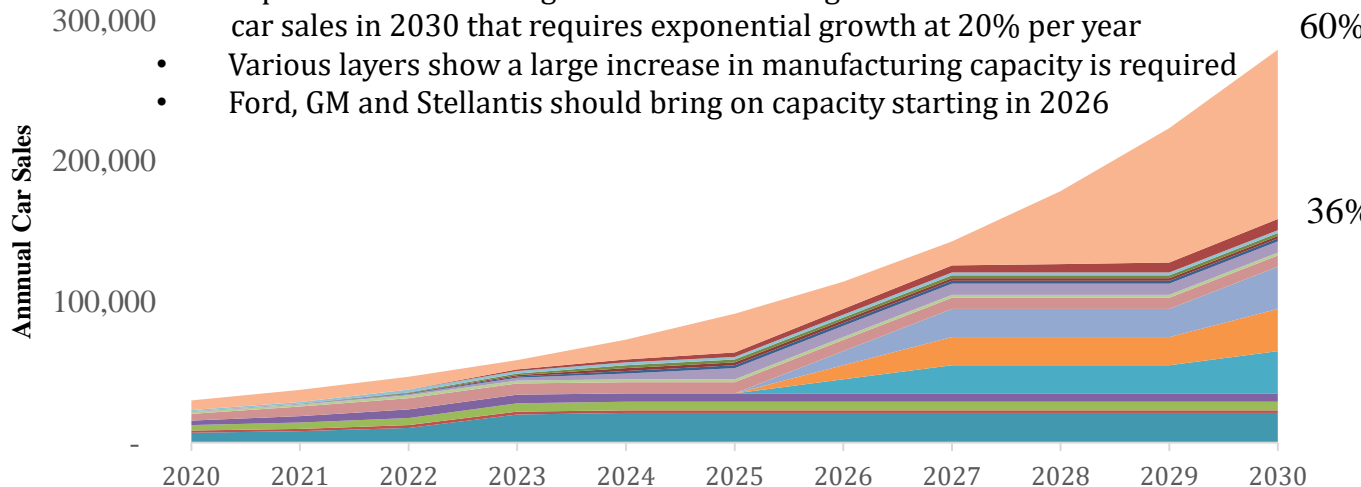
- Model examines two different forecasts for EV sales rates in period from 2022 to 2030
- First forecast (called ERP target) assumes EV sales as contained in ERP
 - Sales for EV passenger cars and EV light trucks rise exponentially from single digits to 60% of all passenger cars and light trucks by 2030
 - Sales for EV heavy freight trucks rise exponentially from single digits to 35% of all heavy freight trucks by 2030
 - ERP does not give any assessment of where these EV vehicles will be built or how likely that they will be built
- Second forecast (called Supply Buildup) is built up from first principles by looking at each EV supplier
 - assumes that EV sales will be constrained by supply, not by demand
 - assesses EV supplier's potential building capacity and eventual sales in Canada

Build up of Increase in Passenger Car EV Sales



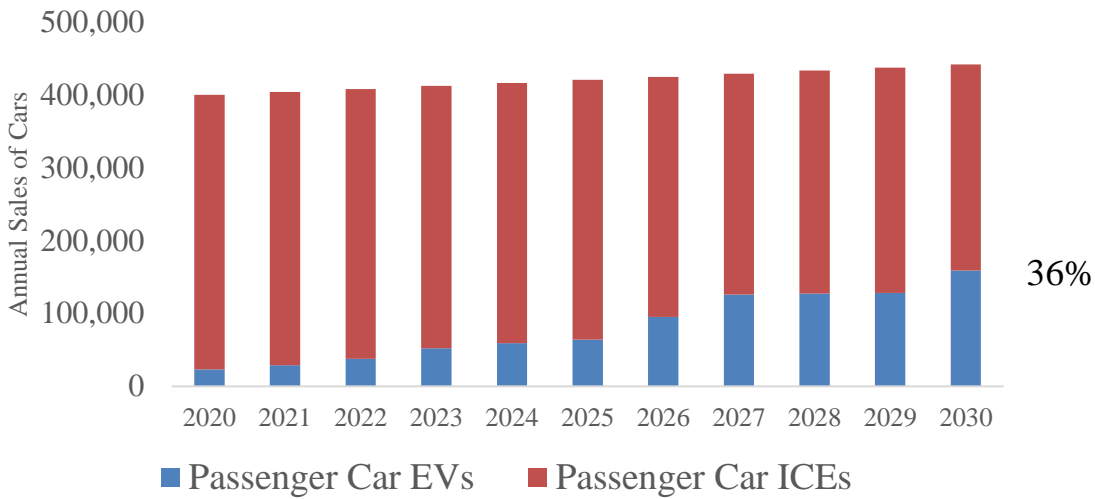
Buildup of Annual EV Car Sales by Manufacturer

- Top line shows ERP target of EV cars forming 60% of car sales in 2030 that requires exponential growth at 20% per year
- Various layers show a large increase in manufacturing capacity is required
- Ford, GM and Stellantis should bring on capacity starting in 2026



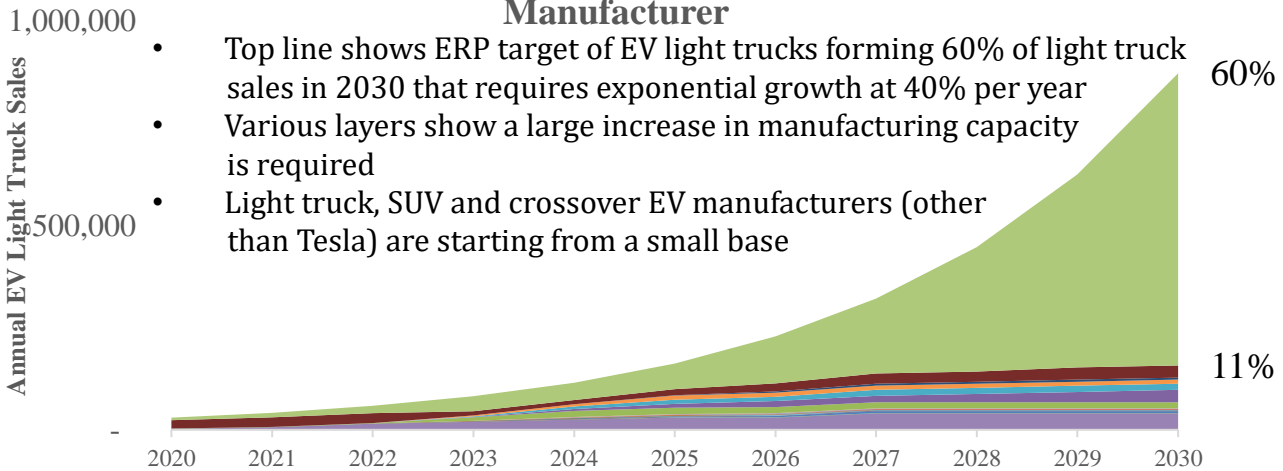
- | | |
|-----------------|--|
| ■ Tesla Model 3 | ■ Tesla Model S |
| ■ Chevy Bolt | ■ Ford Mustang |
| ■ Ford other | ■ GM other |
| ■ Stellantis | ■ Hyundai |
| ■ Kia | ■ Volkswagen |
| ■ BMW | ■ Audi |
| ■ Volvo | ■ Smart |
| ■ Polestar | ■ Nissan Leaf |
| ■ Mini | ■ Mazda |
| ■ Other | ■ ERP target versus Supply Buildup shortfall |

Passenger Car Sales in Canada



- Assumptions:
 - 1% annual growth in total passenger car sales
 - annual growth in EV Passenger car sales (BEVs) based on Supply Buildup
- Result is that passenger car EV sales in 2030 are 36% of total passenger car sales, less than 60% target of ECCC in ERP document

Supply Buildup of Annual Light Truck EV Sales by Manufacturer

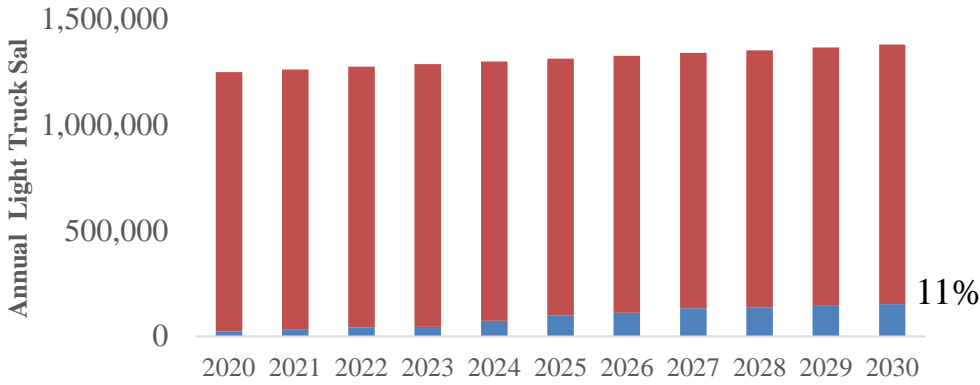


- Top line shows ERP target of EV light trucks forming 60% of light truck sales in 2030 that requires exponential growth at 40% per year
- Various layers show a large increase in manufacturing capacity is required
- Light truck, SUV and crossover EV manufacturers (other than Tesla) are starting from a small base

- Tesla Model Y
- Stellantis Ram Trucks
- GM Equinox
- Audi Etron
- Lordstown
- Ford F150 Lightning
- GM Silverado
- Stellantis Ram Trucks
- ERP target versus Supply Buildup shortfall
- Tesla Model X
- Kia EV6
- Volvo
- Rivian trucks
- Toyota Tacoma
- Tesla Cybertruck
- GM Sierra
- Other

Forecast of Sales of Light Trucks (Including SUVs and Crossovers) in Canada 2020 to 2030

Light Truck (Including SUVs and Crossovers) Sales in Canada

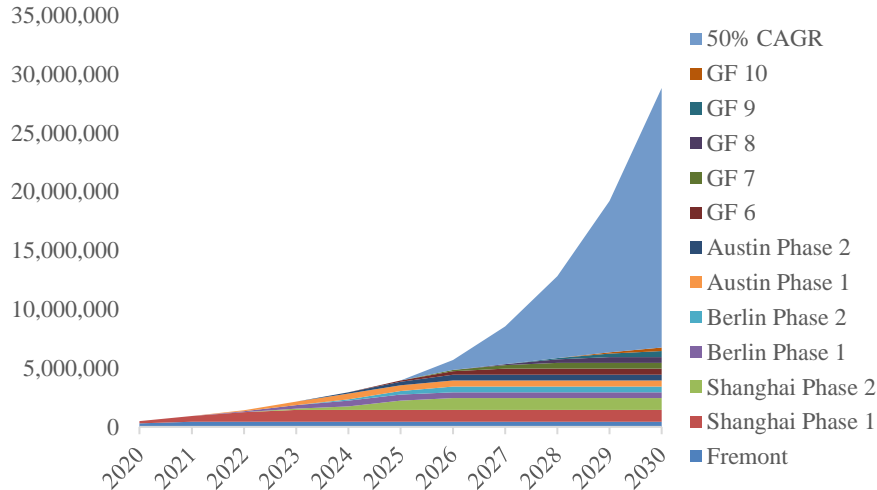


- Light Truck (Including SUVs and Crossovers) ICEs
- Light Truck (Including SUVs and Crossovers) EVs

- Assumptions:
 - 1% annual growth in total light truck sales
 - annual growth in EV light truck sales (BEVs) based on Supply Buildup
- Result is that light truck EV sales in 2030 are 11% of total light truck sales, less than 60% target of ECCC in ERP document

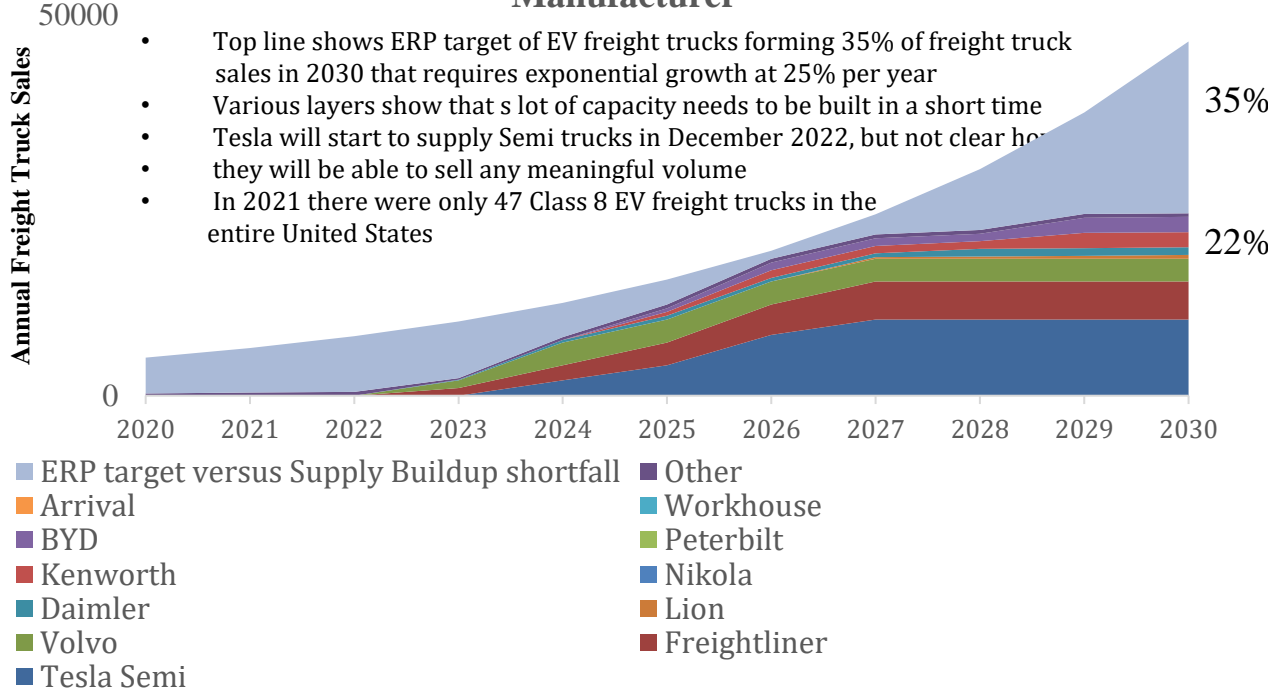
Build up of Increase in Tesla Manufacturing Capacity

Build Up of Tesla Capacity

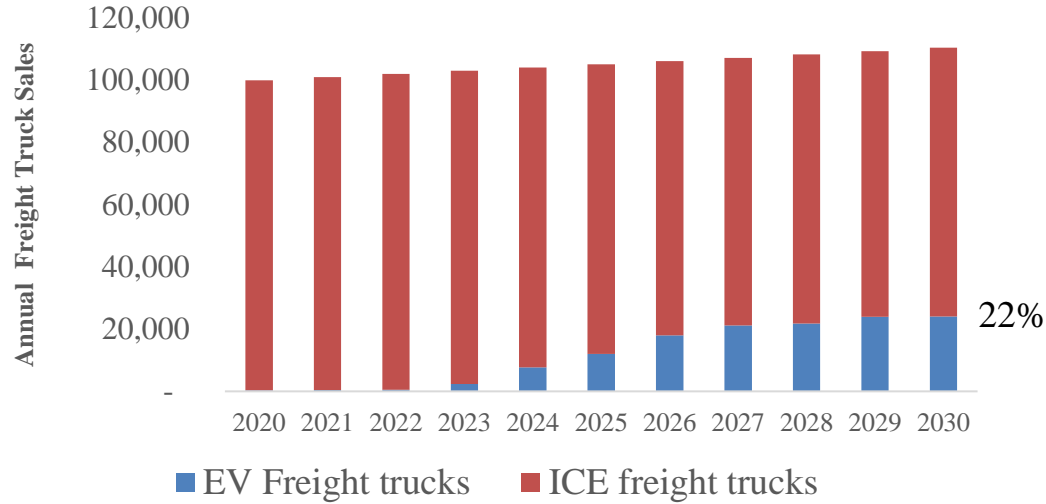


- Graph assumes Tesla adds one Gigafactory (GF) per year with a capacity of 500,000 vehicles per year
- Tesla has stated it will grow capacity at 50% CAGR
- Graph shows this implies a 28 million vehicle per year capacity in 2030, which will be unlikely to be achieved

Supply Buildup of Annual Freight Truck EV Sales by Manufacturer



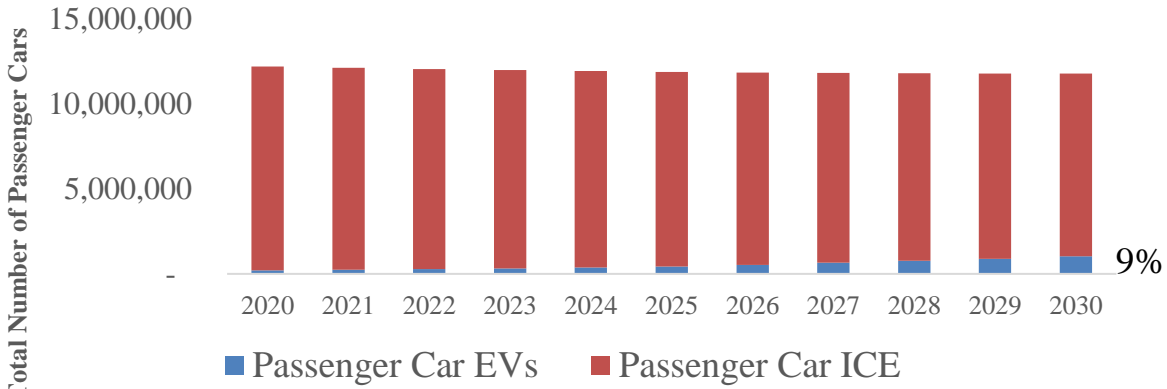
Freight Truck Sales in Canada



- Assumptions:
 - 1% annual growth in total light truck sales
 - annual growth in EV light truck sales (BEVs) based on Supply Buildup
- Result is that freight truck EV sales in 2030 are 22% of total light truck sales, less than 35% target of ECCC in ERP document

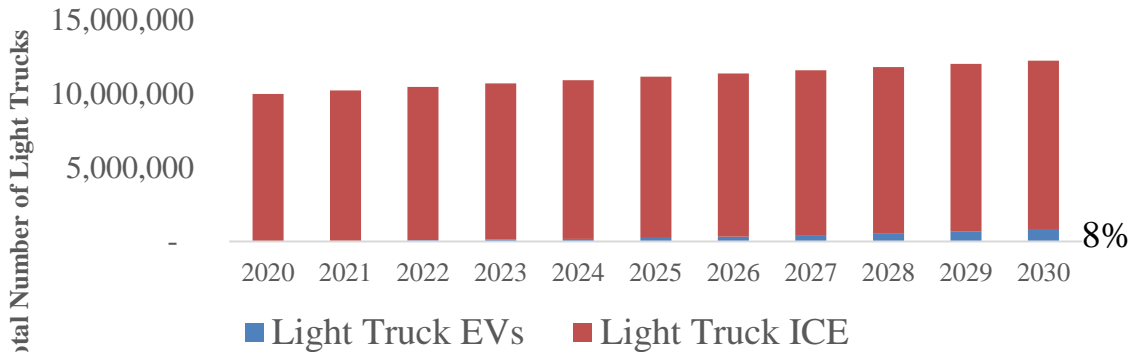
***Forecast of Passenger Car, Light Truck and
Freight Truck Fleets in Canada from 2020 to 2030***

Makeup of Passenger Car Fleet Assuming Supply Buildup Sales of EVs



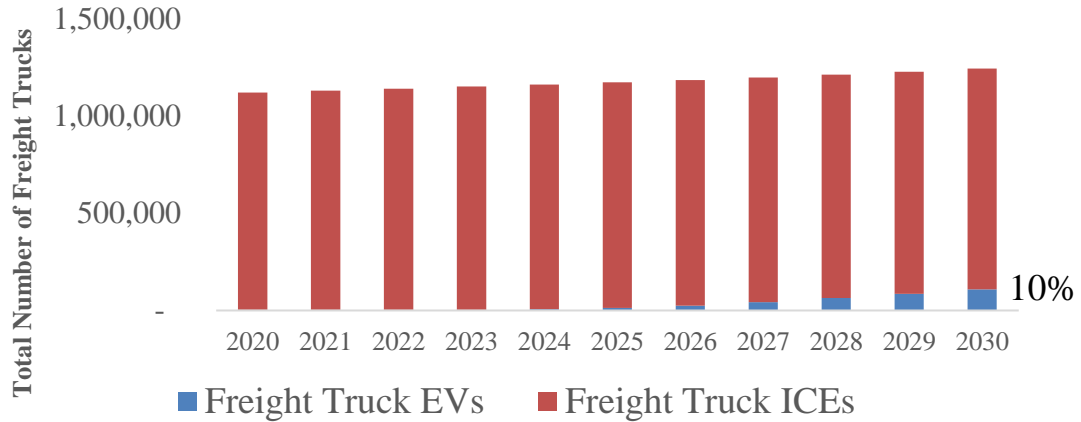
- Car fleet decreases from 12.3 million in 2020 to 11.85 million in 2030
- EVs increase from 200,000 in 2020 to 1.05 million in 2030 based on 36% of car sales in 2030 (9% of fleet)
- ICE cars decrease from 12.1 million to 10.9 million in 2030 (91% of fleet)
- Retirements of ICE cars exceed sales, but still make up most of fleet

Makeup of Light Truck Fleet Assuming Supply Buildup Sales of EVs



- Light Truck fleet increases from 10.0 million in 2020 to 12.5 million in 2030
- EVs increase from 20,000 in 2020 to 1.0 million in 2030 based on 11% of light truck sales in 2030 (8% of fleet)
- ICE light trucks increase from 10 million in 2020 to 11.4 million in 2030 since overall light truck demand increases more than EV light truck sales (92% of fleet)
- Increase in demand for light trucks cannot be satisfied by just EVs

Makeup of Freight Truck Fleet Assuming Supply Buildup Sales of EVs

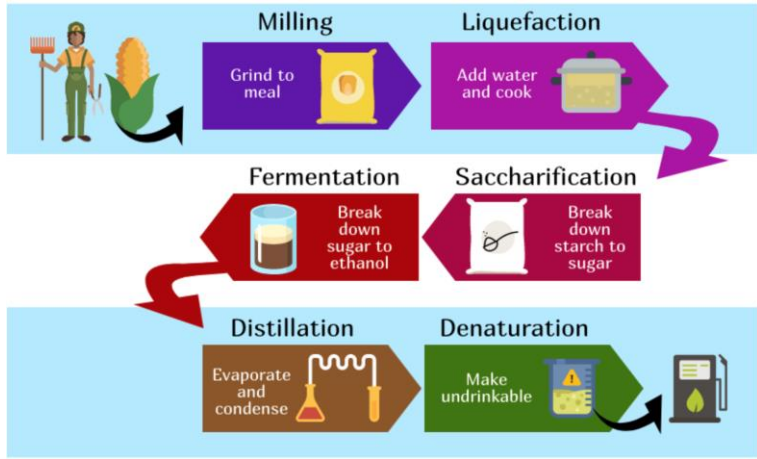


- Freight truck fleet increases from 1.1 million in 2020 to 1.25 million in 2030
- EVs increase from 10,000 in 2020 to 130,000 in 2030 based on 22% of freight truck sales in 2030 (10% of fleet)
- ICE freight trucks stay flat at 1.1 million from 2020 to 2030 (90% of fleet)
- Freight truck EVs meet total freight truck increase

Renewable Fuels

Renewable Fuels for Gasoline, Diesel and Aviation Fuel

Clean Fuel Standard and Renewable Fuels



let's talk science

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- Renewable fuels are ethanol and biodiesel
- Made from wood, crops and vegetable oils, used cooking oil, animal fat waste and even sawdust
- Canadian Clean Fuel Standard regulations impose a requirement for a minimum amount of renewable fuels in gasoline and diesel.
- Imperial Oil is proposing to produce 20,000 bbl/day of biodiesel in 2024 using locally sourced and grown feedstocks.
- Reasonable to assume 1% reduction in ICE emissions per year from 2022 to 2030

Source: <https://letstalkscience.ca/educational-resources/backgrounders/how-ethanol-made>

- Current global production of SAF is 100 million liters per year in 2021
- Canada plans a commercial project of 30 million liters per year for start in 2025
- Many SAF production facilities are proposed around the world
- Reasonable to assume 1% reduction in aviation emissions starting in 2026



*Emissions from Different Vehicles in
2020 to 2030 Period*

Summary of Forecasted Emissions in 2030 for Passenger Vehicles in Canada

- Emissions per vehicle in tonnes per year are assumed to improve by 1% per year due to use of renewable fuels (ethanol and biodiesel)

	<u>2020</u>	<u>2030</u>
Emissions per passenger car	2.7	2.5
Emissions per light truck	5.4	4.9
Emissions per freight truck	58.6	53.2

- EV sales are based on Supply Buildup

Total number of ICE vehicles and Emissions in 2030

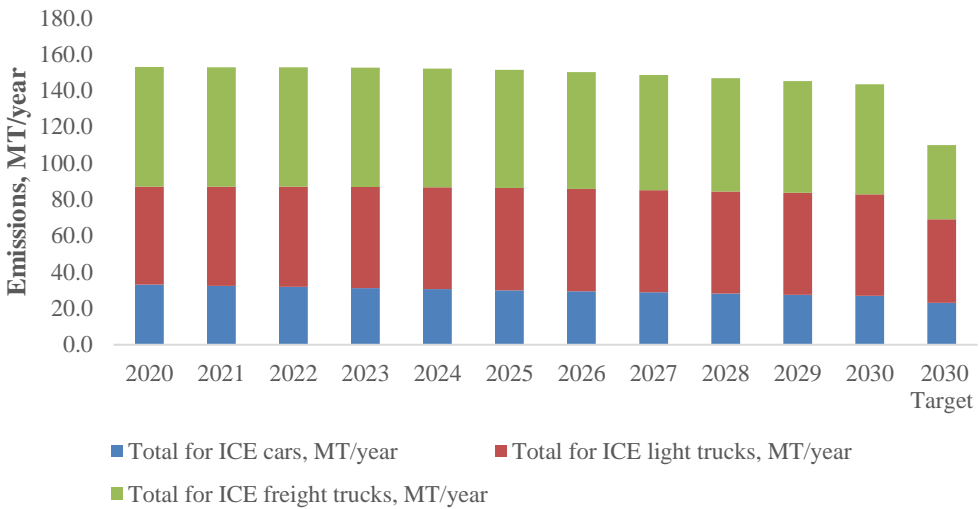
Type of Vehicle	ICE vehicles	Emissions, tonnes per vehicle	Emissions, Total MT	Target Emissions, MT
Passenger cars	10.9 million	2.5	27	23
Light trucks	11.4 million	4.9	56	46
Freight trucks	1.1 million	53.2	<u>61</u>	<u>41</u>
Total			144	110

- Forecast exceeds target by 34 MT

Emissions from passenger cars, light trucks and freight trucks from 2020 to 2030



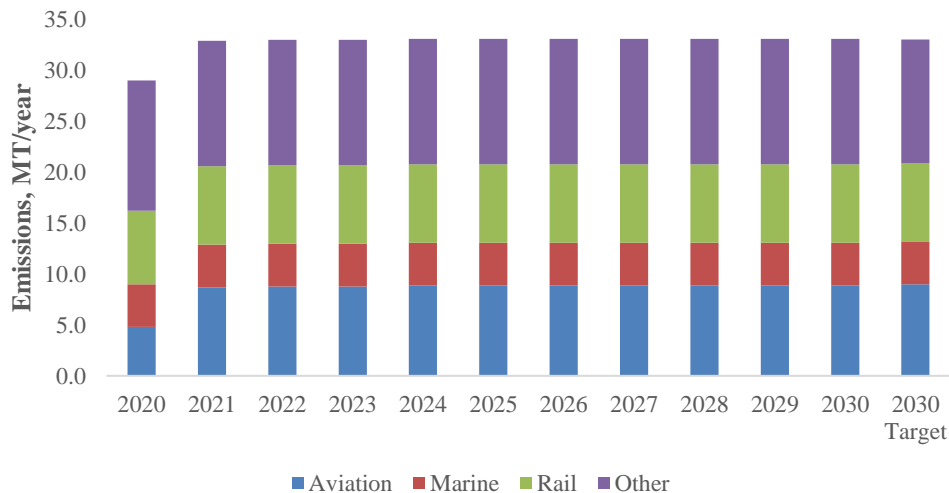
Annual Emissions of Vehicles for 2020 to 2030



- Chart for 2030 shows
 - car emissions come close to target (27 MT forecast versus 23 MT target)
 - Light truck emissions are short of target (56 MT forecast versus 46 MT target)
 - Freight truck emissions are well short of target (61 MT forecast versus 41 MT target)

Aviation Emissions

Annual Emissions of Aviation, Marine, Rail and Other for 2020 to 2030



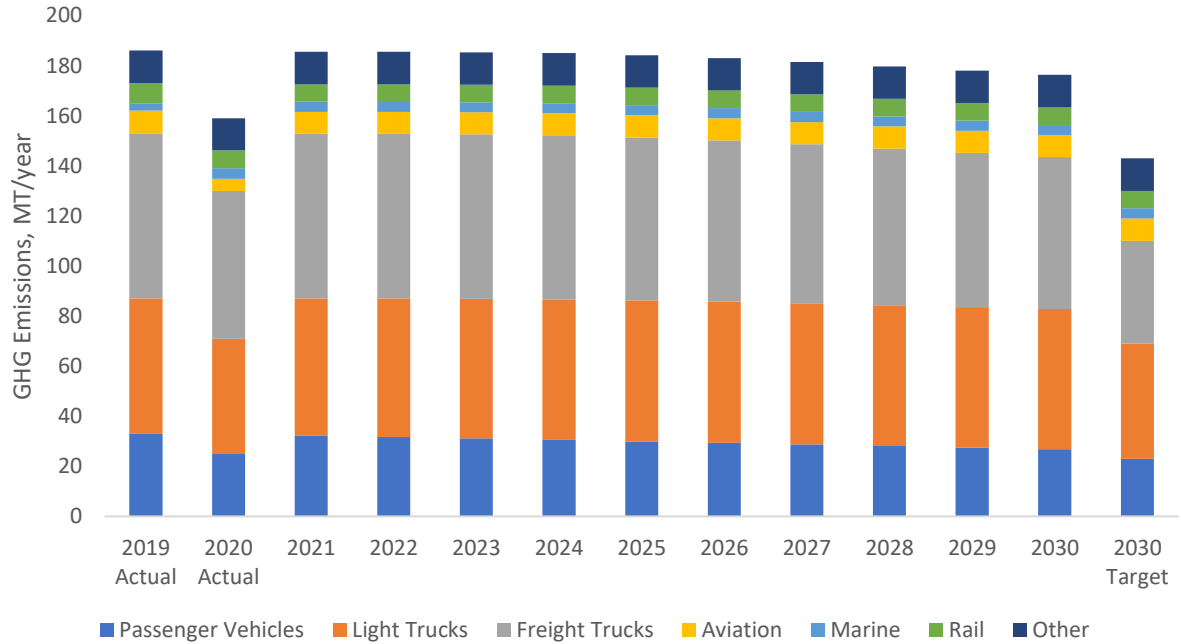
- Emissions for aviation are assumed to remain constant
 - increase in aviation traffic of 1% per year is offset by decrease in emissions intensity of 1% per year due to use of SAF as renewable fuel
- Marine, rail and other are assumed to be the same in 2030 as in 2020

*Final Summary of of Transportation Emissions
for Period 2019 to 2030 Using Model*

Final Summary of Transportation Emissions for Period 2019 to 2030

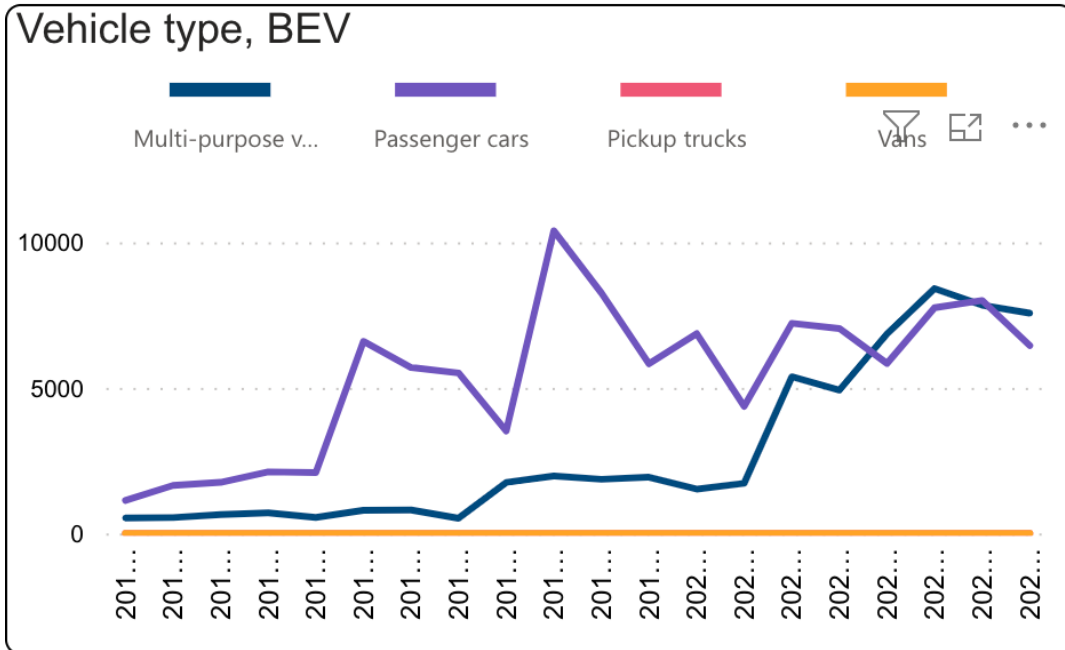


Transportation Emissions, MT/year



- Forecast emissions for 2030 of 177 MT exceeds 2030 target of 143 MT by 34 MT

Backup Charts



- BEV sales in 2021 were only in passengers cars and multi-purpose vehicles (SUVs and crossovers). None in vans and pickup trucks.