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ZeroX2040

Canada's Pathway to Net-Zero for Medium- and Heavy-Duty Trucks and Buses

Introduction:
The drive to clean transportation in 2040

Adam Thorn and Carolyn Kim
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The drive to clean transportation in 2040

By Adam Thorn and Carolyn Kim | November 2023

A decisive moment

This is a decisive decade for Canada and the world. Climate actions taken now will have a profound impact on whether we achieve the national goal of lowering overall greenhouse gas (GHG) emissions by 40% to 45% below 2005 levels by 2030, a crucial milestone and a determining factor in achieving a net-zero economy by the middle of the century.[1] It is during this decade that the international community must advance the boldest of climate actions to avoid the catastrophic effects of climate change and keep the goal of limiting warming within 1.5°C in reach.[2]

The likelihood of Canada meeting its international obligation to transition to a clean energy economy in 2050 depends in no small part on decarbonizing the transportation sector — the largest source of GHGs after oil and gas.[3] In provinces such as Ontario, transportation is the single largest source.[4] While tailpipe pollution generated by passenger cars is in decline, emissions from trucks and buses are trending upward (accounting for approximately 37% of overall transportation emissions).[5] Since 1990, emissions from medium- and heavy-duty vehicles (MHDVs) have nearly doubled and if current trends continue, emissions from MHDVs

[1] Environment and Climate Change Canada, *2030 Emissions Reduction Plan* (2022), 7. https://publications.gc.ca/collections/collection_2022/eccc/En4-460-2022-eng.pdf

[2] IPCC, *Summary for Policymakers* (2018). https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SPM_version_report_LR.pdf

[3] Government of Canada, *Greenhouse Gas Emissions* (2023), 10. https://www.canada.ca/content/dam/eccc/documents/pdf/cesindicators/ghg-emissions/2023/greenhouse-gas-emissions-en.pdf

[4] Canada Energy Regulator, "Provincial and Territorial Energy Profiles – Ontario," (2023). https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-ontario.html#:~:text=GHG%20Emissions,-Ontario's%20GHG%20emissions&text=The%20largest%20emitting%20sectors%20in,7.2%20MT%20CO2e.

[5] Government of Canada, "Canada's Official Greenhouse Gas Inventory," (2023). https://data.ec.gc.ca/data/substances/monitor/canada-s-official-greenhouse-gas-inventory/A-IPCC-Sector/?lang=en

are expected to surpass those of passenger vehicles by 2030 and become the largest source of emissions in the transportation sector.[6]

On the one hand, the movement of goods and people will continue to play a vital role in our economy as population growth, urbanization, and the rise of e-commerce drive up demand. Yet we cannot afford a commensurate increase in transportation-generated emissions. Instead, the economic growth in goods movement must be decoupled from its environmental impact.

Efforts to transition to clean transportation in the federal government's 2030 Emissions Reduction Plan (ERP) — and in its 2021 commitment under the Global Commercial Vehicle Drive to Zero Memorandum of Understanding — include a pledge that 100% of new medium- and heavy-duty vehicles sold by manufacturers must be zero-emission (ZE) vehicles (based on feasibility) by 2040.[7] The federal ERP includes a 2030 target that 35% of all new sales of MHDVs are ZE.[8]

The magnitude of the turnover in the transportation sector cannot be overstated. Assuming sales targets are met, as many as 180,000 electric trucks and buses will be on the road by 2030 and more than 1 million by 2040. The infrastructure for charging and refuelling (for hydrogen-powered trucks) that will be required to support the volume of ZE MHDVs is considerable: The Pembina Institute's modelling shows that by 2030, 70,000 Level 2 (50 kW or higher) private depot chargers for fleets will need to be installed; this will increase to 450,000 by 2050 (Figure 1). Approximately 6,500 Level 3 (100 kW or higher) public chargers will need to be installed by 2030, increasing to 50,000 by 2050. Hydrogen stations for refuelling may need to increase from 2,000 in 2030 to 30,000 in 2050.[9]

[6] Environment and Climate Change Canada, *Discussion paper for heavy-duty vehicles and engines in Canada: Transitioning to a zero-emission future* (2021), 6. https://www.canada.ca/content/dam/eccc/documents/pdf/cepa/21199_HDV%20Discussion%20Document_Dec%2016_MinO%20Approved_Final_EN.pdf

[7] CALSTART, "Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles." https://globaldrivetozero.org/mou-nations/

[8] Environment and Climate Change Canada, *2030 Emissions Reduction Plan*, 57.

[9] Colton Kasteel, Sarah McBain and Chandan Bhardwaj, *Towards Clean MHDVs* (Pembina Institute, 2022), 18. https://www.pembina.org/reports/towards-clean-mhdvs-recommendations.pdf

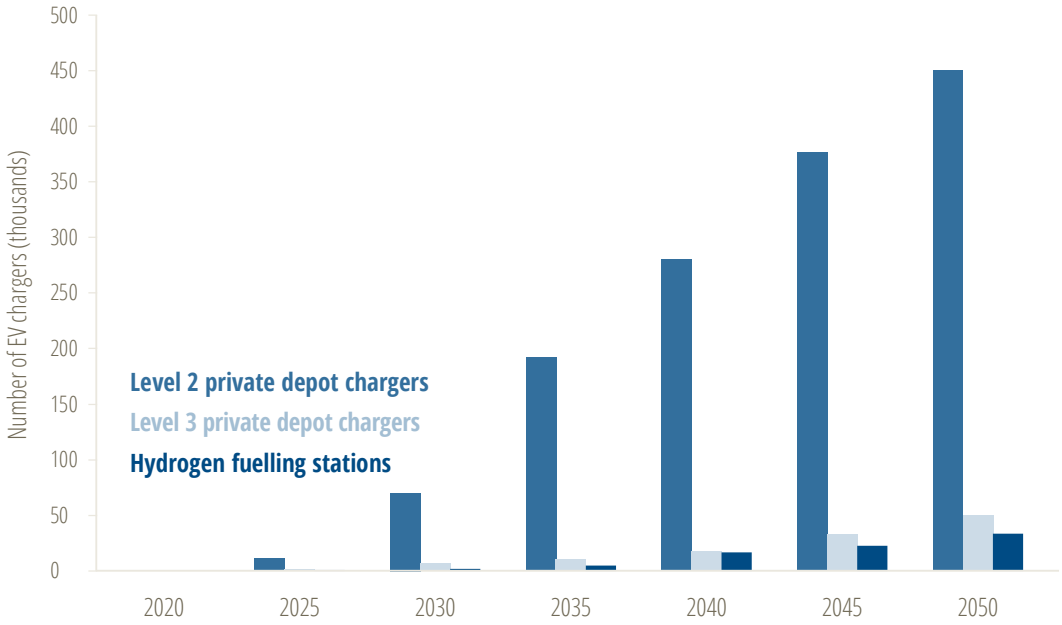


Figure 1. Number of chargers and fuelling stations needed in Canada to support new ZE MHDVs.

Yet, despite the urgency, scope, and limited time frame, Canada has not provided a credible plan to meet either the 2030 or 2040 milestones. Moreover, the levels of adoption of emission-free trucks and buses are not on track to meet the ERP targets; nor is infrastructure build-out close to where it needs to be given the timelines. According to the most recent data, ZE MHDVs constituted 3.7% of total sales of new vehicles in Canada.[10]

Looking ahead, modelling shows that, under the federal government's current suite of climate policies and programs, the transition to clean energy MHDVs will not advance at the pace required to hit the zero-emission MHDV sales targets (Figure 2). Should Canada fail to meet its clean transportation commitments, it is impossible that we will realize net-zero GHG emissions by 2050.

[10] Arijit Sen and Josh Miller, *Vision 2050: Update on the Global Zero-Emission Vehicle Transition in 2023* (International Council on Clean Transportation, 2023), 7. https://theicct.org/wp-content/uploads/2023/09/Global-ZEV-update_final.pdf

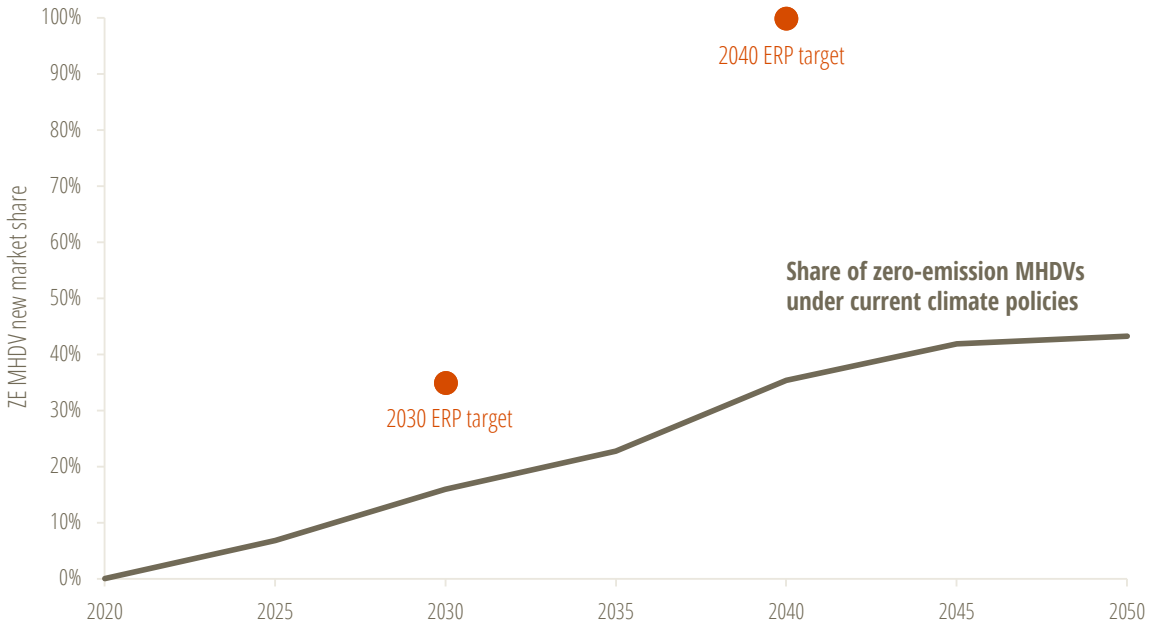


Figure 2. Sales trajectory of new ZE MHDVs under current climate policies

Current climate polices in Canada include the federal carbon price, the Clean Fuel Regulations, and the heavy-duty vehicle GHG emissions standard.

ZeroX2040: A multi-stage strategy for Canada

The Pembina Institute has developed the ZeroX2040 national strategy, *Canada's Pathway to Net-Zero for Medium- and Heavy-Duty Trucks and Buses,* which provides guidance on how Canada can gradually turnover its fossil-fuelled medium- and heavy-duty vehicles to electric and hydrogen-fuelled ones by 2040. Our strategy takes the "beachhead" approach developed by U.S.-based CALSTART and the California Air Resources Board and adapts it to the Canadian context.[11]

Broken down into a two-part report series, we provide more than 20 policy recommendations to overcome the planning gaps and market uncertainties related to the availability of zero-emission heavy-duty vehicles and the necessary infrastructure to support adoption.

- Part I of the ZeroX2040 strategy focuses on zero-emission vehicles
- Part II of the ZeroX2040 strategy focuses on charging and refuelling infrastructure

Our comprehensive strategy offers near- and long-term recommendations that will help Canada meet its ZE MHDV sales target of 35% by 2030 and the 100% target by 2040. By implementing our policy recommendations including the advised sales targets, MHDV carbon

[11] CALSTART, *The Beachhead Strategy: A Theory of Change for Medium- and Heavy-Duty Commercial Transportation* (2022). https://calstart.org/wp-content/uploads/2022/10/the_beachhead_strategy_october_2022.pdf

emissions would decline from 35 Mt in 2020 to 10 Mt or less by mid-century and would drop by as much as 80% by 2050 relative to 2020 levels. (Figure 3).

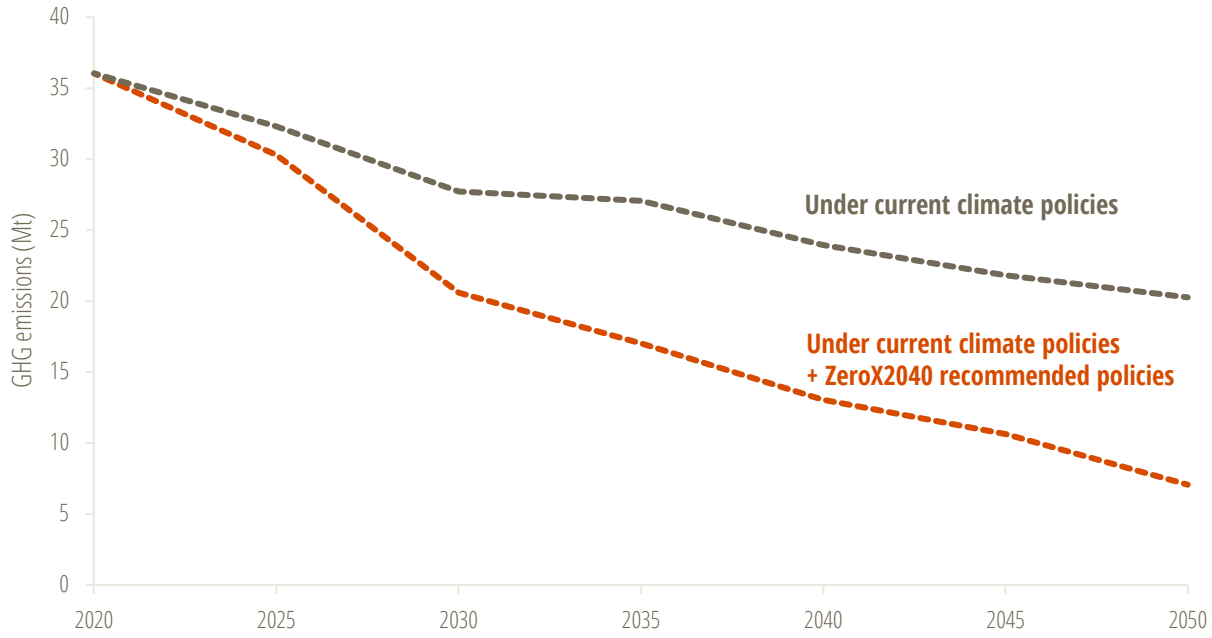


Figure 3. Greenhouse gas emissions from the MHDV sector under current policies compared to ZeroX2040 recommended policies

Central to our recommendations is that Canada implement a strong sales standard. A clear, national standard will determine the speed at which Canada will move from internal combustion to zero-emission trucks and buses. Based on our assessment of market growth and commercial viability in the MHDV sector, the most efficient transition pathway is for the government to institute ZE MHDV sales requirements based on commercial viability rather than implementing a uniform sales target across all MHDV classes.

The sales standard should stagger new sales targets over time according to vehicle type. The most feasible vehicle types to electrify are buses and most medium-duty vehicles (such as a box or pick-up trucks); heavy-duty vehicles, especially long-haul trucks, will take longer to transition as technological advances have been slow and have yet to demonstrate market/commercial readiness at scale.[12] In the first stage of the ZeroX2040 strategy, buses and MDVs are subject to the strongest sales requirements; ZE HDVs will be subject to targets at a later date.

Our strategy twins the sales standard with infrastructure build-out, advising that development sync with the anticipated number of ZE trucks and buses on the road. A well-planned build-out

[12] Colton Kasteel, Sarah McBain and Chandan Bhardwaj, *Laying the Groundwork* (Pembina Institute, 2022). https://www.pembina.org/reports/laying-the-groundwork-mhdvs.pdf

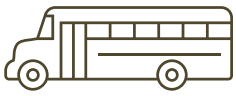
will see an initial push to install private chargers for buses and MDV fleets followed by phased deployment of charging and refuelling stations, with priority initially given to locations that experience the highest electrical load from MHDV charging while also accounting for geographical variability in the pace of ZE MHDV uptake.

A national sales standard for ZE MHDVs

A sales standard requires manufacturers and importers to gradually increase their sales of ZE vehicles over time by a specified percentage of total sales. A regulated sales standard — initially applied to market-ready MDVs such as buses and light-duty trucks followed later by long-haul heavy-duty trucks — means infrastructure planning and construction can be mapped to vehicle requirements that vary among buses, MDVs and HDVs.

In addition, a sales standard provides much-needed certainty for fleet operators. Armed with specific targets, operators can better plan their transition to electric fleets. Similarly, utilities and other entities will have the clarity they need to forecast levels of energy demand in the near future and longer term, and to make critical investments to increase grid capacity and conduct distribution upgrades.

Our recommendations are most aggressive in the bus and MDV classes. In all likelihood, the learnings, innovation, and technological development that occur during the ZE transition of buses and MDVs will ease the later transition for HDVs. Within this context, the Pembina Institute's proposed ZEV sales standard would require that:



Most buses reach 100% ZEV sales by 2030.

Most MDVs reach 50% ZEV sales by 2030, and near 100% by 2040.

HDVs reach up to 10% ZEV sales by 2032 and near 100% by 2045.

Our modelling shows that a ZE MHDV sales standard will result in ZE MHDV adoption that meets (or comes close to) the 35% target by 2030 and the 100% target by 2040 (Figure 4). Other policies such as the carbon price and the Clean Fuel Regulations would also promote sales of ZE MHDVs, but these policies are not sufficient to reach the 2030 and 2040 targets. Instead, by 2050, ZE MHDVs would account for approximately 30% to 60% of new MDV sales and 10% to 50% of new HDV sales – well short of the outcomes needed to successfully transition to emission-free transportation.

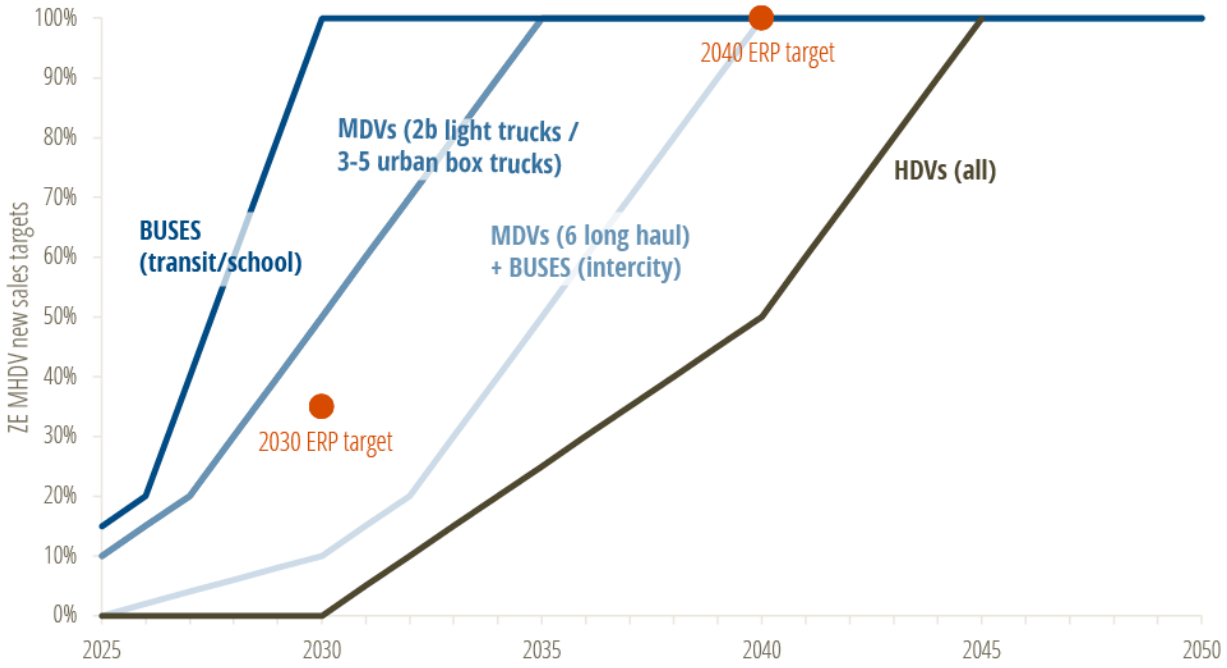


Figure 4. Recommended ZE MHDV sales targets across different MHDV classes

An accelerated ZEV sales target can be applied to manufacturers of buses and MDVs. For HDVs and some difficult-to-electrify buses and MDVs, manufacturers have a longer period to meet the 100% ZEV sales targets.

That said, the sales standard, on its own, will not be sufficient to drive uptake of ZE MHDVs to the levels needed. Complementary policies and regulations must be in place as well. Key measures that will need to be implemented include demand-side measures that incentivize purchaser uptake and capacity building efforts to upskill a labour force so that it is equipped to work in a ZEV-dominated auto market.

Infrastructure build-out

Electrifying heavy-duty vehicles is one of the biggest technological challenges in the ZEV sector, and insufficient charging infrastructure remains a significant barrier to adoption of ZE MHDVs.[13]

To date, federal investment in charging and refuelling infrastructure covers only 20% of the estimated cost of constructing a national network that can meet the needs of the anticipated number of MHDVs on the road by 2030. Canada must be deliberate in how it builds out a charging network and consider measures that will mobilize private capital to invest in charging stations. Initially, installing infrastructure primarily in depots servicing private fleets will be

[13] Pembina Institute, *Laying the Groundwork*, 27-28.

prioritized given that ZE buses and MDVs are the first sub-classes to scale up and will require adequate charging accessibility.

As more ZE HDV models come onto the market, investment will need to pivot to the deployment of publicly accessible, high-power charging and refuelling stations, which should first be built along highways, trade routes, and regional corridors that have been identified through federal-provincial-municipal collaboration.

Financing infrastructure and ZEV manufacturing

Overall, financing the turnover to zero-emission vehicles will be comparable in scale to the historical investments made federally and provincially in Canada's roadways, railways and all associated infrastructure. Two federal programs — the Zero Emission Transit Fund and the Zero Emission Vehicle Infrastructure Program — have been established to support the deployment of a charging and refuelling network for MHDVs.[14,15] We recommend increasing funding to both programs, while simultaneously identifying new financing opportunities and revenue streams to support a network that can meet demand. At the same time, the strategy we are putting forward encourages concentrating investments on strategically chosen locations and dispersing those investments in discrete increments.

Financing will also be needed between now and 2030 to support the production of ZE MHDVs and incentivize adoption. We estimate that by approximately 2030, ZEVs will have reached cost parity with ICE vehicles and the level of financial support required now will taper off considerably in less than 10 years.[16] Workers in the automotive industry will require training and learning opportunities that can be applied to ZEV manufacturing and operations; a labour force prepared for the electric vehicle transition will be critical not only to adequate domestic uptake, but also to Canada's ability to retain a competitive edge in the global marketplace.

The environmental, economic, and health benefits of sustainable transportation

Climate and clean energy: GHG emissions from the MHDV sector would drop by as much as 80% by 2050 relative to 2020 levels should the federal sales standard incorporate our

[14] Infrastructure Canada, "Zero Emission Transit Fund." https://www.infrastructure.gc.ca/zero-emissions-trans-zero-emissions/index-eng.html

[15] Natural Resources Canada, "Zero Emission Vehicle Infrastructure Program." https://natural-resources.canada.ca/energy-efficiency/transportation-alternative-fuels/zero-emission-vehicle-infrastructure-program/21876

[16] CALSTART, "Global MOU on ZE-MHDVS – Thematic Deep Dive Series #4: Incentives," November 1, 2022. https://globaldrivetozero.org/event/global-mou-on-ze-mhdvs-thematic-deep-dive-series-4-incentives/

recommended targets. According to our analysis, MHDV emissions would decline from 35 Mt in 2020 to 10 Mt or less by mid-century.

Modelling scenarios additionally show that energy consumption will be reduced by more than 25% from 500 PJ in 2015 to 400 PJ in 2050. On average, ZE MHDVs are far more energy efficient than diesel-powered vehicles. While putting more ZE MHDVs on the road increases the electricity consumption of MHDVs, total energy consumption, which includes gasoline, diesel fuel, and, to a lesser extent, other power sources, decreases due to greater efficiencies in how energy is used. An important added benefit for Canada is enhanced energy security due to reduced dependence on external sources of energy and considerably less exposure to price volatility in the oil and gas market.

The transition to ZEVs will have a compounding effect to Canada's overall emissions profile as it directly impacts demand for oil and gas. In the IEA's 2022 World Energy Outlook, under a scenario where all EV sales targets and efficiency goals are met on time and in full — including targets for MHDVs — oil demand for road transport peaks in the mid-2020s and falls by almost half by 2050.[17] Bloomberg New Energy Finance (NEF) estimates show that electric and fuel cell vehicles will displace 21 million barrels per day in oil demand by 2050, and, further, that demand for gas and diesel for road transport has likely already risen as far as it's going to go in the U.S. and Europe, while demand in China is set to peak in 2024.[18]

In a scenario singling out the impact of ZE MHDVs in Canada on oil demand, under current climate policies, demand for oil would decrease by 26% by 2050 relative to 2020 levels. Under a scenario in which sales targets are met in full and on time, demand for oil in the MHDV sector would decrease by 80% relative to 2020 levels. Essentially, fossil fuels will be replaced by clean electricity and hydrogen.

Economic opportunities: The transition to ZEVs is a conduit to multiple economic opportunities, from establishing a robust domestic EV production supply chain to construction and build-out of new infrastructure. Manufacturing electric vehicles, parts and components are a potential windfall for Canada's ailing MHDV sector, which has been in decline since 2008 and today is operating at only 60% of its pre-Covid production levels.[19] Canada's contribution to

[17] International Energy Agency, *World Energy Outlook 2022* (2022), 327-329. https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf

[18] BloombergNEF, *Electric Vehicle Outlook 2023* (2023), 6. 2431510_BNEFElectricVehicleOutlook2023_ExecSummary.pdf

[19] International Organization of Motor Vehicle Manufacturers, "Production Statistics." https://www.oica.net/category/production-statistics/2022-statistics/

global commercial vehicle production has fallen from a high of 6.8% in 2016 to 3.5% in 2021.[20] With demand for ZE trucks and buses poised for explosive growth, the many Canadian small- and medium-sized businesses already experienced in parts manufacturing for large vehicles can be re-tooled to supply a burgeoning ZEV sector and reclaim lost market share.

The skills requirements and jobs in the auto sector are already changing. According to Clean Energy Canada, roughly 7,000 Canadians were employed in the EV sector in 2020. That number is expected to grow to 184,000 by 2030.[21]

Demand for critical minerals to manufacture ZE MHDVs (such as copper and aluminum) and batteries (such as lithium and cobalt) is anticipated to grow exponentially as markets pivot to electrification across all vehicle types.[22] Canada is a major player in the mining sector. The country ranks among the top 10 producers of graphite, nickel, cobalt, and aluminum and has one of the world's largest identified lithium reserves.[23,24]

Confidence in the ZE MHDV market as a growth industry has increased and capital has been unlocked to support the manufacturing of battery production for MHDVs specifically. For example, Lion Electric opened an automated battery-pack assembly plant in Quebec this year with federal and provincial support of nearly $100 million.[25]

Health: Positive health outcomes will result from a decline in air pollution caused by diesel exhaust, which has been linked to incidences of asthma, cancer and respiratory diseases. According to Health Canada, traffic-related air pollution contributes to 1,200 premature deaths in Canada yearly. A 2022 Health Canada report attributed 63% of those deaths to exhaust from MHDVs.[26] Moreover, people experiencing socioeconomic marginalization are

[20] IBIS World, "Truck and Bus Manufacturing in Canada – Market Size (2004-2029)," September 12, 2023. https://www.ibisworld.com/canada/market-size/truck-bus-manufacturing/

[21] Clean Energy Canada, *The New Reality* (2021), 10. https://cleanenergycanada.org/wp-content/uploads/2021/06/Report_CEC_CleanJobs2021.pdf

[22] International Energy Agency, *Global Electric Vehicle Outlook 2022* (2022), 175. https://www.iea.org/reports/global-ev-outlook-2022

[23] Invest in Canada, "EV Supply Chain." https://www.investcanada.ca/industries/ev-supply-chain

[24] Natural Resources Canada, "Lithium facts." https://natural-resources.canada.ca/our-natural-resources/minerals-mining/minerals-metals-facts/lithium-facts/24009

[25] Government of Canada, "Major investments by Canada and Quebec in electric vehicle battery assembly," March 15, 2021. https://www.pm.gc.ca/en/news/news-releases/2021/03/15/major-investments-canada-and-quebec-electric-vehicle-battery-assembly

[26] Health Canada, *Health Impact of Traffic-Related Air Pollution in Canada* (2022), 3. https://publications.gc.ca/collections/collection_2022/sc-hc/H144-91-2022-eng.pdf

disproportionately impacted by transportation-related air pollution and the associated health outcomes.[27]

Not only do ZE trucks and buses help clear the air, but a significant reduction in tailpipe emissions also promise substantial savings for Canada in avoided healthcare costs. Pollution-induced health-related economic costs amount to $120 billion a year (6% of the country's GDP)[28], most of which can be avoided by shifting to ZE MHDVs and substantially lowering pollution levels.

Conclusion

Under the Paris Agreement, Canada has committed to making changes that will help keep global average temperature rise below 2°C and ideally below 1.5°C. The real measure of progress will be in the immediate actions taken during this decade to drive down emissions.

For Canada to achieve its 2030 climate goal of 40% to 45% emissions reductions and to be carbon-neutral by the middle of the century, emissions produced by the MHDV sector – which account for approximately 37% of national transportation-related greenhouse gases, the largest of any sub-sector – need to be a priority for Canada's climate ambitions.

At the national level, the federal government must embark on a rapid response to transport-related carbon emissions by establishing clear targets that will guide the shift to non-emitting heavy-duty trucks and buses and by providing a comprehensive plan that addresses the issue of market readiness, the need (temporarily) for robust purchase incentives, and the financial support to build a charging network that can meet near-future energy demands. The ZeroX2040 strategy provides actionable policy recommendations which Canada can deploy to get on track and in line with the climate goals that the federal government has committed to.

Absent a credible roadmap and investment strategy, or the policy coordination to accelerate transition at scale, we risk losing Canada's ZE vehicle supply to other jurisdictions, sluggish market transformation, and quite possibly failing to meet climate targets.

The International Council on Clean Transportation highlights the importance of Canada achieving its commitment to the global Drive to Zero and the federal ERP targets, noting that "…if major markets reach 100% ZEVs for sales of new light-duty vehicles (LDVs) by 2035 and new heavy-duty vehicles (HDVs) by 2040, and all other countries follow suit within 5 to 10

[27] Jane McArthur, "Opinion: 'The air we breathe, I don't feel like I have any control over that,' *Canadian Association of Physicians for the Environment*, May 9, 2022. https://cape.ca/opinion-the-air-we-breathe/

[28] Health Canada, *Health Impacts of Air Pollution in Canada* (2021), 4. https://www.canada.ca/content/dam/hc-sc/documents/services/publications/healthy-living/2021-health-effects-indoor-air-pollution/hia-report-eng.pdf

years, it is possible to put the sector on a pathway consistent with keeping warming below 2°C."[29]

[29] *Vision 2050: Update on the Global Zero-Emission Vehicle Transition in 2023,* i.