Zero Emission Vehicle Awareness Initiative

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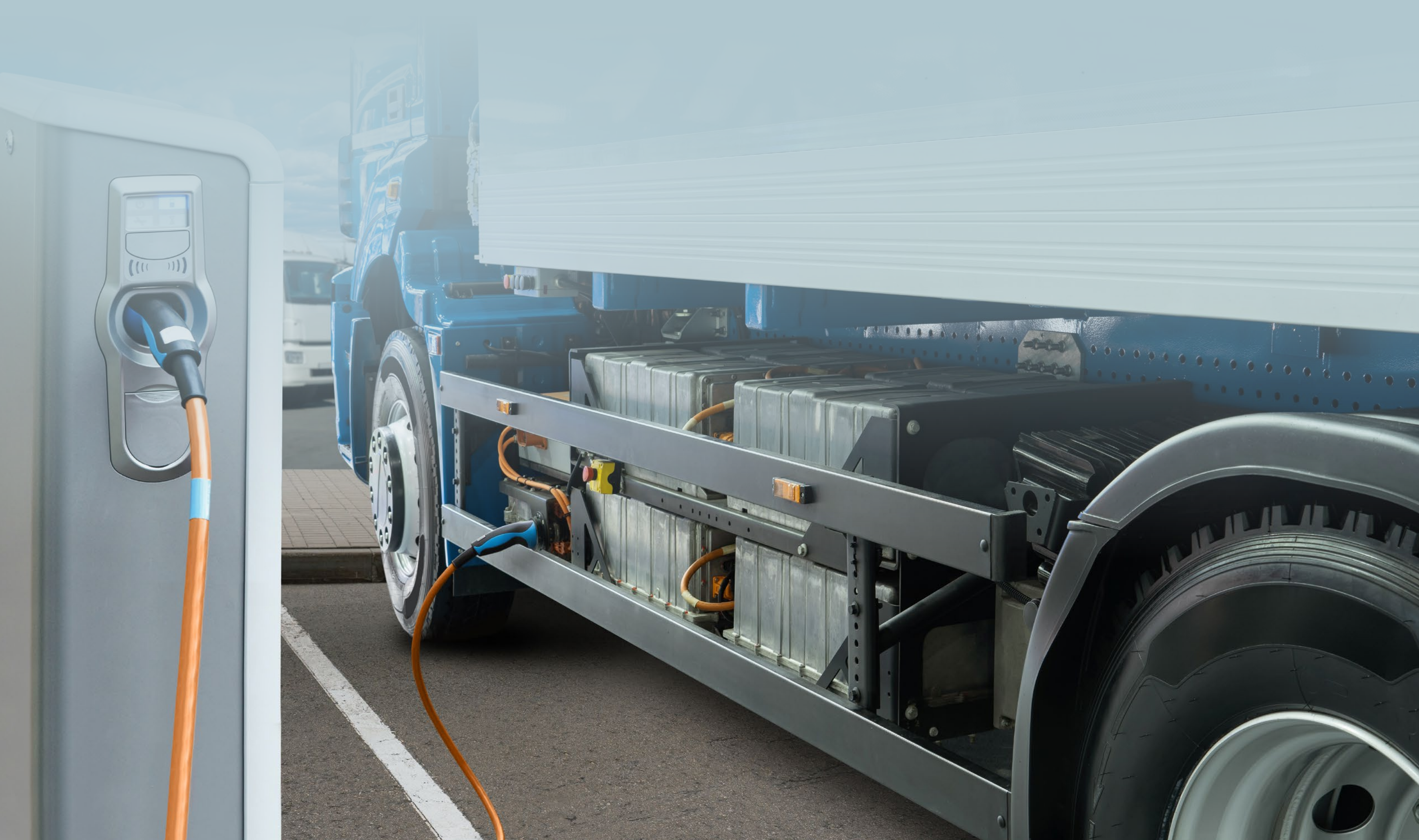

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ZEV TECHNOLOGY AND INNOVATIONS

Zero Emission Vehicle (ZEV) Technology

ZEVs, primarily electric vehicles (EVs), have seen rapid advancements in battery technology, motor efficiency, and charging infrastructure. Key innovations include improvements in lithium-ion batteries, solid-state battery technology, and fast charging capabilities.

Batteries

Lithium-ion (Li-ion) batteries dominate current battery technologies in EVs due to their superior energy density, efficiency, and lifespan compared to other types of rechargeable batteries.

However, emerging battery technologies, particularly solid-state batteries, represent a significant innovation in this area. Solid-state batteries still use lithium but differ from traditional lithium-ion batteries by using a solid electrolyte instead of a liquid one, allowing for more energy in a smaller space.[1] This battery type is also less flammable and may allow for faster charging. Solid-state battery technology is still in the development phase, with challenges related to manufacturing, degradation, and scalability that need to be overcome. Moreover, they do not eliminate the need for lithium mining.

To combat the need for lithium mining, research is being done on sodium batteries as an alternative for EVs, and sodium-ion-based vehicles are starting to be rolled out in China. Sodium, being more abundant and widely distributed, offers a more sustainable and potentially cheaper raw material for battery production.[2]

Charging Technology

There are several notable up-and-coming advancements in EV charging technology, such as ultra-fast charging stations and wireless charging.

Ultra-fast charging technology (i.e., level 4 charging) is capable of delivering more power than current DC fast chargers. These chargers are still very expensive and in the development stage. EVs must be equipped with at least 800-volt architecture to use these stations, which are currently only available in Kia, Hyundai, Porsche, and Audi EVs.[3] These chargers could add 100 km charge in 4 minutes.[4] By other definitions, level 4 charging is 1 MW or more charging capacity, such as the Tesla Megacharger for its electric semi-truck.[5] This level of charging will make medium- and heavy-duty electric vehicles (MHDEVs), such as semi-trucks, more feasible.

Wireless EV charging is emerging as a solution to simplify EV charging by eliminating the need for cables. This system utilizes magnetic resonance to create a power-transmitting field between a charging pad and a receiver installed under the vehicle, allowing energy transfer across distances up to 10 inches. Although the concept is gaining interest, the technology currently faces challenges such as slower charging speeds than fast chargers and high initial costs. Efforts are underway to standardize wireless charging protocols to enhance interoperability and safety, anticipating that advancements in vehicle technology, like autonomous driving and bidirectional charging, could further integrate wireless charging into future transportation networks.

[1] Crownhart, "What's next for batteries"

[2] ibid

[3] McCredie, "EV Charging - everything you need to know"

[4] Kia, "Everything you need to know about EV charging"

[5] Subramanian, "Tesla Semi unveiled with tri-motor setup, megawatt charging tech"

[6] Alake, "Wireless Charging for Electric Cars is Inching Closer to Reality"

Other ZEV Innovations

EVs are at the forefront of the evolution in autonomous driving technology, as the simpler electric drivetrains allow for better integration with digital systems and, thus, advanced sensors, machine learning algorithms, and connectivity solutions.[7] EVs with autonomous features use advanced sensors like LIDAR, radar, cameras, and ultrasonic detectors to gather data about their environment. An example of this is the Waymo Jaguar I-Pace all-electric fleet for their autonomous robo-taxi fleet.[8]

Vehicle 2 Grid (V2G) technology leverages the battery storage capacity of EVs to enhance grid stability, store excess renewable energy, and provide backup power during peak demand periods when the vehicle is connected to a charger. Through V2G, EVs can be charged during times of low demand and excess generation – such as midday peaks of solar power production – and then discharge part of their stored energy back into the grid when demand is high or renewable energy generation is low, such as during the evening peak or on days with less available solar or wind energy.[9] There are hurdles to this technology around regulation, compatibility, grid communication, and cybersecurity, but V2G pilots are occurring in Denmark, the UK, and the Netherlands.[10]

MHDZEVs vs. ZEVs

MHDVs make up a significant portion of transportation emissions, hence the need for MHDZEV options, which are generally behind passenger adoption and availability.[11] This sector is growing, however, with the largest use cases for MHDZEVs being delivery vehicles, school and transit buses, regional freight trucks, and other work vehicles.[12]

However, there are unique challenges to electrifying MHDs, including higher up-front costs, the need for new infrastructure, lack of access and strain on grids, the effect of battery sizes on cargo load, and potential conflicts with recharging and hours of service.[13] Despite these challenges, EV options exist across every truck class from 1–8.[14]

Rural/Remote Versus Urban Adoption

In urban settings, the adoption of electric vehicles (EVs) shows a promising trend. One study showed that more educated and wealthier “Core Urban” New Yorkers had higher adoption rates compared to “Rural,” “Suburban,” and other “Urban” populations.[15] Urban areas typically benefit from shorter travel distances, higher population densities, and better charging infrastructure, all of which facilitate the transition to ZEVs.

Conversely, rural and remote areas encounter unique challenges that hinder the swift adoption of ZEVs. For instance, the lower population densities and longer travel distances in rural areas pose significant obstacles to cost-effective transit services.

[7] Mo and others, “Trends and Emerging Technologies for the Development of Electric Vehicles”

[8] Westbrook, “Waymo Retiring Self-Driving Chrysler Vans, Replacing Them With Way Mo’ Electric Jaguars”

[9] Mo and others, “Trends and Emerging Technologies for the Development of Electric Vehicles”

[10] ibid

[11] Gagnon, “CLEARING ROADBLOCKS FOR ZERO EMISSION MEDIUM- AND HEAVY-DUTY TRANSPORTATION”

[12] ibid

[13] ibid

[14] Snohomish PUD, “Class 1-8 commercial models”; Transport Canada, “iMHZEV - Eligible vehicles”

[15] Rames and others, “A data-driven mobility–energy typology framework for New York State.”

While challenges exist for rural EV adoption, they are not insurmountable. For example, a study out of Australia, which has lower than average EV adoption rates, found that over 99% of communities and residents could travel to their closest hub town with current EV technologies (although large service hub towns are not necessarily feasible for these residents).[16] This may paint a similar picture for Canada due to its similarly large landmass and low population density.

The major hurdles to EVs in rural and remote regions of Canada, as noted by the BC Rural Centre, are the high upfront cost of an EV, range anxiety around longer trips, lack of charging infrastructure, and worries about rural power grids.[17] However, they also noted that EVs are often cheaper than internal combustion engine vehicles over their lifetime, the range required for most driving of rural residents could be covered by an EV, charging infrastructure is growing with federal incentives, and energy grids are also being quickly updated with the help of additional federal incentives.[18]

For rural farmers, one area of opportunity for electric adoption is with tractors. For example, Case released production-ready tractors that can run up to 4 hours on a charge and start being delivered in 2024.[19]

One particularly challenging area for EV adoption is the Far North. EVs make up 0.1% of new vehicle sales in the territories as of 2022.[20] While many of the challenges mentioned above are also acute in the territories, there is also the issue of how cold climates affect EVs. In particular, cold weather can severely adversely affect battery range, with a temperature below -20 degrees Celsius decreasing range by up to 50%.[21]

16 Demaria and others, "Exploring the feasibility of electric vehicle travel for remote communities in Australia."

17 Johnson, "What's needed to get EVs into rural Canada."

18 ibid

19 Garvey, Case IH electric tractor ready for release"

20 Whitestone, "How remote communities should be included in the push to electrify transportation"

21 ibid

MARKET TRENDS AND ECONOMIC FACTORS

ZEV Trends

Market trends differ greatly across the globe. EV adoption is especially strong in Norway, making up most newly sold passenger vehicles, and it is growing quickly in China.[22] Korea leads in fuel cell EV (FCEV) growth with over half of the global FCEV stock.[23] In Canada, 2023 saw ZEV sales at 10.8% of total market share, with 8.1% battery electric vehicles (BEVs) and 2.6% plug-in hybrid electric vehicles (PHEVs).[24]

The EV sector is nearing a point where the total cost of ownership for EVs is competitive with internal combustion engine (ICE) vehicles, driven by lower energy and maintenance costs. However, this depends on where you live and how long you own the vehicle, as costs vary across Canada.[25] This cost competitiveness is expected to strengthen with time, bolstered by advancements in EV technology and increased economies of scale.[26]

MHDZEVs Trends

By the end of the decade, zero-emission commercial vehicles are projected to capture a 28% share of the combined European, American, and Chinese markets.[27]

The transition to MHDZEVs is largely influenced by tightening regulations on ICE vehicles and the decreasing total cost of ownership for electric and fuel-cell vehicles. The evolution toward zero-emission models is also shaped by the need for commercial vehicle makers to adapt by accelerating the launch of electric vehicles, developing charging infrastructure, and innovating business models.[28]

California is a leader in this department as it set ambitious targets for ZEV adoption, aiming for 100% of new passenger car and truck sales to be zero-emission by 2035 and a similar target for MHD vehicles by 2045.[29]

Despite technical and economic challenges, this market is expected to shift more rapidly toward ZEVs than many may anticipate. For instance, the US Department of Energy projects that by 2030, nearly half of medium- and heavy-duty trucks will be cheaper to buy, operate, and maintain as ZEVs than traditional diesel-powered vehicles. By 2035, zero-emission electric medium- and heavy-duty trucks will be cost-competitive with diesel trucks, thanks to advances in battery and hydrogen fuel cell technologies.[30]

While concerns about the weight of batteries or the size of hydrogen tanks affecting payload are valid, ongoing advancements in technology aim to reduce these impacts. For instance, regulatory exceptions currently accommodate these disadvantages, and future improvements in battery energy density and hydrogen storage are expected to mitigate payload concerns further.[31]

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22 IEA, "Trends in electric light-duty vehicles"

23 ibid

24 Electric Autonomy Canada, "StatsCan reports Q4 2023 ZEV registrations at 12 per cent, fractionally lower than Q3"

25 Little, "Can an EV save you money? It depends on where you live and how much you drive."

26 Ewing, "Electric Vehicles Could Match Gasoline Cars on Price This Year"

27 Wiedenhoff and others, "What the Shift to Zero-Emission Vehicles Means for Commercial Transportation"

28 ibid

29 State of California, "Zero-Emission Vehicle Market Development Strategy"

30 US Department of Energy, "DOE Projects Zero Emissions Medium- and Heavy-Duty Electric Trucks Will Be Cheaper than Diesel-Powered Trucks by 2035"

31 Becker and others, "Preparing the world for zero-emission trucks"

Rural and Remote ZEV Economics

However, there are also economic opportunities. For example, a goat farm in Ontario used a federal tourism grant to install two EV charging stations for visitors. Although it may not be a huge income producer, it allows for rural charging infrastructure, allows more people to visit the farm and cafe, and is a more environmentally friendly business.[32] Three townships in East-Central Ontario have also banded together to launch an EV rental pilot program since the area lacks Ubers and taxis, promoting economic development and environmental benefits.[33]

ENVIRONMENTAL IMPACT AND OTHER BENEFITS

ZEV Impacts

ZEVs have many positive impacts from an environmental and health perspective. Many life cycle analyses demonstrate that EVs have less environmental impact over the vehicle's lifetime, even though they are higher up-front in battery manufacturing and lithium mining. One Chinese study showed that fossil energy consumption is 40.1% lower for EVs, and greenhouse gas emissions are 26.6% lower than ICE vehicles.[34] Similarly, a European study found that EVs powered by the current European electricity mix offer a 10–24% decrease in global warming potential.[35]

On the health and environment front, one study highlighted that ZEV adoption in California significantly reduced ground-level ozone and PM2.5 concentrations, which could lead to health savings of approximately $28 billion annually by 2045.[36] Similarly, a University of Toronto study found that converting all cars and SUVs in the Greater Toronto and Hamilton Area would lead to 313 fewer deaths yearly and $2.4 billion in social benefit.[37]

Moreover, there are potential benefits of V2G technology, including its role in reducing grid peak demand and providing grid support services.[38] This demonstrates that V2G technology could increase the environmental benefits of EVs and provide infrastructure benefits.

MHDZEV Impacts

MHDZEVs, such as electric trucks and buses, are crucial for decreasing transportation-related greenhouse gas emissions. Since these vehicles account for a considerable share of emissions, transitioning to electric options can significantly impact air quality and climate change mitigation efforts.[39] A study in Chicago found that electrifying just 30% of heavy-duty vehicles would save around 610 people a year and have some of the largest beneficial impacts in disadvantaged communities.[40]

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32 Nicholson, "Canada needs hundreds of thousands of public EV charging ports. Who is going to build them?"

33 Yakub, "EV rental programs expanding in Canada's rural and northern communities"

34 Wu and Sun, "Energy and Environmental Impact of the Promotion of Battery Electric Vehicles in the Context of Banning Gasoline Vehicle Sales"

35 Hawkins and others, "Comparative Environmental Life Cycle Assessment of Conventional and Electric Vehicles"

36 Forrest and others, "Emissions and Air Quality Implications of Enabling On-Road Vehicles as Flexible Load Through Wide Scale Zero Emission Vehicle Deployment in California"

37 U of T News, "U of T researchers model the health benefits of electric cars, find 'large improvement in air quality'"

38 Viswanath and others, "Vehicle-to-Grid (V^2G) Optimization for Grid Peak Demand Reduction and Decarbonization: A State-of-the-Art Review"

39 Lohawal and Spiller, "From Diesel to Electric: Overcoming Grid Integration Challenges in the Medium- and Heavy-Duty Vehicle Sector"

40 Morris, "Electrifying heavy-duty vehicles could reduce environmental inequalities"

Reducing emissions from the MHDV sector addresses climate change and significantly benefits public health, especially in communities disproportionately affected by transportation pollution. There is already momentum from governments, manufacturers, and fleet operators aiming for a significant shift toward electrification.[41]

Impacts on Rural and Remote Communities

While many of the benefits mentioned above are also true for rural and remote communities, the electricity mix in these regions could lessen the positive impact of EV adoption. For example, NRCan's ZEV infrastructure program saw no applications from Nunavut, but the territory relies heavily on diesel, and therefore, increasing demand would offset some of the benefits of using an EV.[42]

However, this is not true in all rural and remote regions. The Yukon, for example, generates 80% of its electricity through renewable hydroelectricity, making it a prime candidate to experience the environmental benefits of EV adoption.[43]

Another benefit of ZEV adoption for rural and remote communities is the jobs that come from mineral mining and refining, parts production, and EV and battery manufacturing.[44] These jobs could be especially important to areas that have suffered economic declines due to the outsourcing of manufacturing in the past or provide new economic potential for underdeveloped regions.

POLICY FRAMEWORKS AND INCENTIVES

ZEV Adoption Frameworks and Incentives

Policies and incentives play a crucial role in promoting the adoption of EVs. A study examining the effect of such measures in 20 countries found that tax reductions, charger density, and income levels are significant factors influencing EV market share. These findings demonstrate the importance of sustained government support to facilitate the EV transition.[45]

Canada's approach to zero-emission vehicles (ZEVs) includes a comprehensive strategy that addresses key barriers to ZEV adoption, focusing on incentives, infrastructure development, awareness initiatives, and research into alternative fuel opportunities. The nation has committed to decarbonizing its transportation sector, aiming for 100% of new light-duty vehicle sales to be zero-emission by 2035.[46] On top of this target, yearly minimum ZEV sales targets are set for manufacturers and importers from the 2026 model year onward. Manufacturers can also receive compliance credits for investing in new charging infrastructure.[47]

41 Spiller and others, "Medium- and Heavy-Duty Vehicle Electrification: Challenges, Policy Solutions, and Open Research Questions."

42 Bonasia, "EV Infrastructure Falls Behind in Rural, Northern Communities"

43 Whitestone, "How remote communities should be included in the push to electrify transportation"

44 Government of Canada, "Zero-emission vehicles"

45 Xue and others, "Impact of Incentive Policies and Other Socio-Economic Factors on Electric Vehicle Market Share: A Panel Data Analysis from the [20] Countries"

46 Transport Canada, "Canada's Zero-Emission vehicle sales targets"

47 Cullen and others, "Jumpstarting Zero-Emission Vehicle Adoption in Canada"

Moreover, there's a growing recognition of the importance of building a supply chain for ZEVs within Canada. This involves focusing on the sustainable extraction and processing of critical minerals, the development of battery materials and technologies, and the manufacturing and assembly of electric vehicles and their components. These investments can also set Canada up for global competition in the EV market.[48]

Provincial EV initiatives are also complementing federal efforts. For example, Quebec's Zero-Emission Vehicles (ZEV) standard requires automakers to supply the Quebec market with a minimum number of EVs.[49] British Columbia has implemented rebates for individual EV buyers as well as for fleets.[50]

MHDZEV adoption frameworks and incentives

Canada has implemented significant policy frameworks and incentives for Medium- and Heavy-Duty Zero-Emission Vehicles (MHDZEVs). The Incentives for Medium- and Heavy-Duty Zero-Emission Vehicles (iMHZEV) Program, announced in July 2022, is a notable part of Canada's approach. This four-year, approximately $550 million program aims to assist businesses and communities across the country in adopting zero-emission vehicles by offering purchase incentives. These incentives can cover up to 50% of the price difference between an electric vehicle and its traditional counterpart, with a potential subsidy of up to $200,000 per vehicle. This federal incentive is designed to complement provincial or territorial incentives, enhancing affordability for Class 2B to Class 8 eligible vehicles such as the Ford e-Transit cargo van and the Volvo VNR-electric tractor truck.[51]

Canada's approach aligns with initiatives like California's HVIP program but is distinguished by its national scope. Additionally, Canada's broader strategy includes a federal ZEV mandate, Low Carbon Fuel Regulations, and Clean Electricity Regulations to support the adoption of ZEV and low-carbon transportation options.[52] Canada is also a signatory to the Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles, which seeks to have 30% MHDZEV sales by 2030 and 100% by 2040.[53]

One of the most ambitious plans for MHDZEV transitions is the California Advanced Clean Trucks regulation, which will require manufacturers to start transitioning in 2024 with a goal of 100% short-haul and drayage trucks by 2035.[54] For the US as a whole, the Inflation Reduction Act provides one billion dollars toward electrifying class 6 and 7 trucks.[55]

[48] West and others, "Shaping the future of Canadian industry with zero-emission vehicles"

[49] Gouvernement du Québec, "The zero-emission vehicle (ZEV) standard"

[50] CleanBC, "Passenger vehicle rebates for individuals"; CleanBC, "Passenger vehicle rebates for fleets"

[51] Transport Canada, "Minister of Transport announces new Incentives for Medium- and Heavy-Duty Zero-Emission Vehicles Program"

[52] PNWER RIA, "Canada's Example for MHD ZEV Incentives"

[53] Drive to Zero, "Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles"

[54] Environment and Climate Change Canada, "Discussion paper on heavy-duty vehicles and engines in Canada: transitioning to a zero-emission future"

[55] EPA, "Clean Heavy-Duty Vehicles Program"

Rural and Remote Incentives and Supports

The policy frameworks and incentives for ZEVs in Canada, particularly concerning rural and remote regions, are built into many strategies and programs to enhance ZEV uptake.[56] For example, NRCan is funding Indigenous-led projects that address EV adoption challenges.[57]

Moreover, rural and remote regions are implementing programs to facilitate EV adoption. For example, Hydro-Québec implemented charging stations early on across the province, including in less populated areas, and now has a more even distribution of EV ownership across urban and rural areas compared to other regions.[58] Two projects have also sprung up – Peaks to Prairies in Southern Alberta and Accelerate Kootenays in BC – that have led to 32 high-speed charging stations as largely grassroots initiatives with support and funding from governments and other partners.[59]

Indigenous communities have also looked to increase EV adoption with programs such as the Indigenous Clean Energy's Charge Up program, which provides funding for EV charging stations in indigenous communities.[60] The Malahat First Nation has also spearheaded a new battery factory on Vancouver Island, which is set to be completed in 2025.[61]

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[56] Government of Canada, "Zero-emission vehicles - policies and regulations"

[57] Natural Resources Canada, "Funding for Indigenous-led awareness and education projects for cleaner transportation and clean fuels"

[58] Wallcraft, "The key to more even EV ownership between urban and rural areas? Charging infrastructure"

[59] ibid

[60] ICE, "Charge Up"

[61] Cawson, "Malahat Nation partners to build Canada's biggest battery factory"